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SCIENCE

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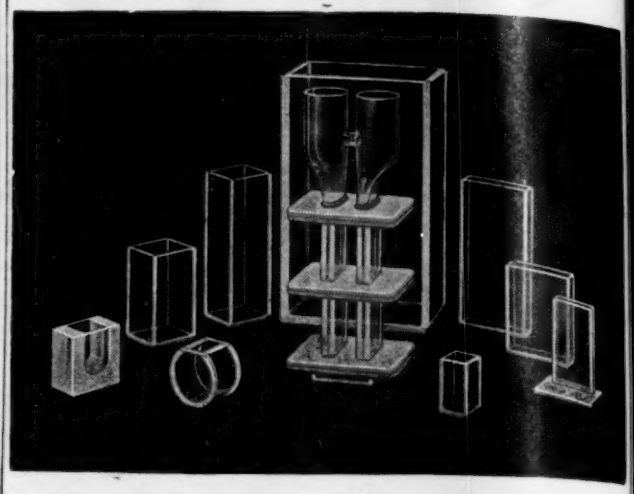

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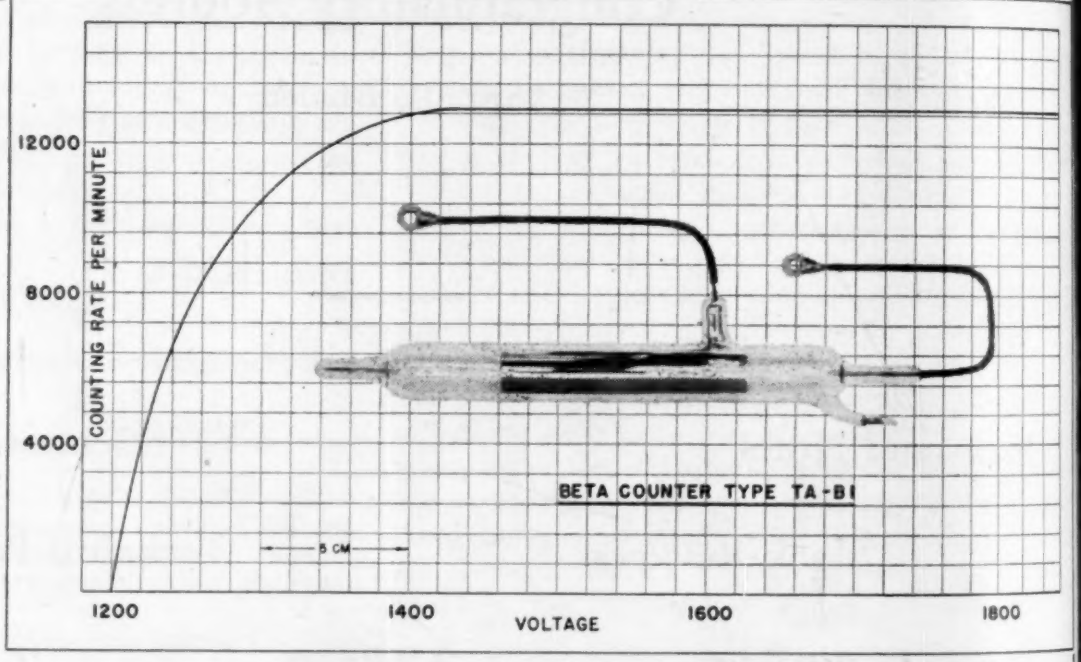

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SCIENCE

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The Millionth Map of Hispanic America

Isaiah Bowman

President, The Johns Hopkins University

THE MILLIONTH MAP OF HISPANIC AMERICA had its remoter origin in a personal experience of 1913 when, for the third time, I was preparing to go to South America on an expedition which had the good fortune to be sponsored by the American Geographical Society. My plans included a study of settlements on the margin of the pre-cordillera of northwestern Argentina and of the arid Puna de Atacama that marks the meeting place of Bolivia, Argentina, and Chile in the Central Andes. A base map for field notations was required and, though I searched the files of the principal collections in this country, I could find no map suited to the purpose. It was necessary to construct one, and a quick compilation was made to suffice. But in putting together the pieces of then-existing maps and in seeing on the ground the errors of earlier compilations, it seemed to me that a base map for all of Hispanic America was a first desideratum if we were to do serious geographic work in that vast territory in the years ahead and not waste the time of successive scholars, for the most part ill-equipped to do a

The desirability of a world map on a uniform scale was first brought to official international attention in 1891 at the International Geographical Congress held at Berne, when Dr. Albrecht Penck, then professor of geography at the University of Vienna, urged the scale of 1:1,000,000. Resolutions were adopted confirming the appointment of an international committee to attain this objective. United States members on this committee were Major J. W. Powell, then director of the U. S. Geological Survey, and Dr. W. C. Mendenhall, then geologic aid in the Survey and later its director.

The map was discussed at the International Geographical Congresses of 1899 and 1904, but no generally acceptable scheme of action could be found because of national loyalties—notably the reluctance of the British geographers to accept the metric system for the map and the insistence of the French geographers that its meridian of origin should be through Paris rather than through Greenwich.

Credit for bringing the discussions to a head, as well as for certain noteworthy contributions to the scheme of symbolization that was ultimately adopted, must go to Henry Gannett, the geographer of the U. S. Geological Survey, who exhibited a series of maps of states of the United States, showing relief by close contours in brown, at the International Geographical Congress held at Washington in 1904. This now-familiar convention contributed largely to the final decision to use this method of representing topography on the International Map rather than the hachures and hill shading favored by the Germans and French. Furthermore, his proposal of a 1:1,000,000 scale was unanimously accepted by the International Geographical Congress at Geneva in 1908 and led to the adoption of a series of resolutions dealing with the style, scale, and symbolism of the map.

To make these resolutions official, the British Government invited an International Map Committee to meet in London the following year. It is from the year 1909, when this meeting was held, that the International Map is generally dated.

The completion of the American Geographical Society's Map of Hispanic America, conforming in scale and style to the International Map of the World on the scale of 1:1,000,000—about 16 miles to an inch, was announced on 19 December 1945. The event was celebrated by a dinner for the Council at the Rainbow Room, Rockefeller Plaza, New York City, on that date. Dr. Bowman, who was director of the Society in 1920 when the work was started, spoke as recorded here. Mr. Spruille Braden, Assistant Secretary of State, whose long experience in South America forms a useful background for his remarks, spoke as recorded in part on pages 323–325.

The 107 sheets of the map cover all the land areas of the American continents from the Mexican-United States boundary to Cape Horn, including the West Indies, a total of about 8,000,000 square miles, or nearly one-sixth of the land surface of the globe. The task of producing the map has required the labor of an average of seven compilers, draftsmen, and editors working continuously for 25 years; the total cost of research, compilation and drafting, publication, and supplies has been nearly half a million dollars.

cartographic job expertly. Not only would the work of compilation of each cartographically untrained student be badly done—an amateurish compilation would be unsystematic and patchy and, in fact, unscientific and unscholarly—but there was also the question of how the job could be done for the whole of Hispanic America in one lifetime.

Two short years after my expedition of 1913 I became director of the American Geographical Society and found in its Council and members a spirit of enterprise that helped generate a feeling of happy accord with respect to future plans. The first World War interrupted these plans, but directly thereafter it was possible to launch a program of research in Hispanic America in which the Millionth Map played an important part. This is surely the place to say that there would have been no map and no Hispanic-American program of research if we had not had the support of Archer M. Huntington. Generous as his financial help has been, it is the lesser of his two gifts to this enterprise. His buoyant spirit is combined with a critical instinct and a scholarly approach. We have drawn liberally upon his intellectual strength. We are proud of the map, but we are equally proud of our association with him in an objective undertaking that has called out the best in the men engaged upon it.

In opening a program of Hispanic-American research I was anxious lest the quality and grand purposes of it be not fully understood. It would have been easier to choose a second-best plan, one of small scope, and coast to a near and undistinguished goal. A more austere point of view had to be taken. It would only make the plan and the Society second rate to concentrate energies and funds upon anything less good than the best. For is it not true that every time we consciously choose the second best our stature and our usefulness are diminished thereby? A first-class project inspires others also to reach for the stars, and though we all fail to touch them, the *effort* is what produces those powerful waves that wash the farthest shores of thought and action. A learned society can never be great through second-best performance or through mere advertising or by acquiring a large membership and revenues, but only through its generative or germinant power in men's minds. Thus, the American Geographical Society is not a building with collections and a staff at 156th Street and Broadway, New York, but an idea, a standard, and a wholesome force wherever men read its publications.

The scale of 1:1,000,000 is not what gives the map its peculiar distinction, but if one is going to do a map of Hispanic America, it is obviously wise to fit it into an existing scheme if this be possible without sacrificing quality and usefulness. I have heard it said of the Hispanic-American map that the millionth scale is not a new idea. This quite misses the point. It was deemed wise to advance the high desirable Millionth Map of the world (agreed upon in 1909 by international action), while constructing a map of the particular area we had in view. It was the promotion of scholarly studies in Hispanic America on the part of students everywhere in the Western Hemisphere that was the grand objective and the map was one instrument for such study. It was better to have it on the scale of 1:1,000,000 and thus secure the advantages of comparative studies of the world map on this scale advanced toward completion. I have used both the millionth sheets and the 1:500,000 compilations in the field and can testify that for most purposes they serve admirably. Photostatic enlargements of the source material used in the compilation, and available to any serious student at the Society, provide maps on scales that meet every need.

I hope that as time goes on and the number of source maps increases the millionth sheets will be constantly revised. Thus, a quality of endless growth would be introduced into the Hispanic-American program. Assuredly, the value of the source material will increase in time, and the Society will become, accordingly, a unique Western Hemisphere center for cartographic research. When Bancroft assembled his great collections in the field of Western history (now at the University of California), it was said that perhaps $250,000 went into the project. Today probably no library possessing it would sell it, but if it were to do so, its appraisal could hardly be under $10,000,000. The Society's great collection of source material is in this class, and in 50 or 100 years it will be a convenience and provide a stimulus to geographers second to no other like collection in the world.

The Millionth Map will bear comparison with the illuminated books of medieval time, for it was drawn by hand and is embellished with color. One important difference between the medieval book and the Millionth Map is that map printing has enabled us to reproduce in admirable color design the original drawings in thousands of copies, whereas each of the illuminated hand-drawn medieval books was unique. The lithographic art has been developed to the point which permits a very high standard of beauty to be coupled with mass production. Each sheet of the Millionth Map can be enjoyed for its aesthetic qualities. Indeed, these overshadow the utilitarian in my mind as I pick up each new sheet. While no printed book or map has the brilliance of an illuminated hand-drawn original, it can be said of the Millionth Map that it represents a level of beauty close to that of the medieval manuscript. This brief comparison is in-

ded to link the map to a great tradition and a h point in human enterprise, supplying energy d artistic impulse to the dissemination of the word. To me it has always seemed remarkable that mem- rs of the conference of representatives of many ntries at London in 1909 should have had the od sense and good taste to devise standards of color, aftsmanship, and composition that have stood so ell the test of the intervening years and that have n improved only in detail.

May I say a word about projections and the so- lled new way of looking at the earth on an occasion at celebrates a map of conventional projection and sign? One of the popular pastimes of the war riod has been the construction of maps viewed from nusual angles and presented to us in popular style devotees of the so-called "new cartography." izarre projections have certainly made a splash in e ocean of public interest. In so far as they have timulated popular interest in maps, I suppose we an say that the effort has been well expended. But ey have given the public some quite erroneous im- pressions of the broader purposes of maps. If one accustomed to seeing Tibet on a map with the north t the top, it takes a mental wrench to see it with the south at the top. Since a mental stimulus is its wn excuse for being, the new cartography has its lace in education. A stereotyped view of a country s likely to become a dull view. We should *think* as men might who approach a country from any direc- tion. I wish to point out, however, that this is only a convenience to a man who does not understand maps or read them readily. I wonder if a Gallup Poll would not show that those who have to have their orientations adjusted to the angle of their imaginative approach really are in a state of com- plete confusion when they have finished with their examination of the world, or parts of it, from strange and constantly changing angles of view. I am in- clined to conclude this from my own experience with the public, but I hesitate to draw a wider general- ization.

It is essential, in any case, that we have conventional maps that can be used for comparative purposes from country to country throughout the world. The Millionth Map represents a bold attempt to satisfy such a need. In a remarkably short space of time—indeed, in little more than a third of a century start- ing from scratch—we have had the greater part of the world represented on this scale. The Millionth Map of Hispanic America has taken a continent and a half out of a state of cartographic disorder into one of order, and thus it has so far advanced the world map that the urge to complete it is now higher than ever. The enterprise whose completion we cele- brate tonight has been accomplished at a cost of a half million dollars, which is remarkably low when we consider that the highest craftsmanship, not the lowest, has marked its construction throughout. It is now possible readily to compute the cost of the unfinished portion of the map and plan for its com- pletion.

We can all take pride in the fact that the map rep- resents mutuality of interest among the geographers of the world and hardly less among scholars in other fields who use maps for comparative purposes—the historians, the archaeologists, the foresters, the an- thropologists, and all those whose imagination is quickened, whose research instincts are affected, or whose teaching processes are promoted by drawing designs upon a base map that show where it is popu- lated and where the heaviest or the lightest densities occur, whether of people, of forests, of minerals, or of agricultural production. Government today rests upon the adding machine as well as the electorate, the executives, the legislature, and the courts. Unless regular censuses are taken and the statistics analyzed, no government can deal intelligently with its people, its production, its internal social organization, its pub- lic health requirements, and its grander schemes of water control, whether for irrigation on the one hand or for drainage of excess water on the other.

To gather the statistics that are pertinent to national administration is one of the most important elements of intelligent government today. It is a part of the fact-gathering that Plato commended in describing his House of Wisdom. Unless a government is re- sponsive to the principle so well stated by Bagehot, that "it is the business of government to evoke new power," it will find itself governing people of which it does not know the number or the distribution and shaping its administrative measures for peoples and environments for which it has not provided the means of analysis. From the beginnings of government ages ago it has been learned a thousand times that good government and good statistics are inseparable; and wise administration demands full statistics—full in the sense of meeting all the requirements of a coun- try's social program, including the general develop- ment of human aptitudes and higher standards of living, two essential elements of an efficient national power plant.

Seen in this light, the Millionth Map is not merely a map to "glance at," as writers commonly say, and then to drop on the table. It is part of a great human experiment, creative and stimulating, whereby man is brought into rational relation with nature. The map happens to be a tool, however, that is different from any other in the experiment to which I am alluding. Compared with a book, it is expensive to make and it

is useful almost in proportion as it covers a large extent of territory. The grander comprehensions of geographical science are over and above the meanings of the minute and local. The local must be studied for accurate detail, but the geographer is obliged also to bring the detailed parts into relationship if the realisms of human societies are to be understood. Indeed, this is his chief function. In doing so he must generalize, or his vocabulary becomes diffuse and his thought restricted to local neighborhoods. To bring the results of his work within the scope of government, industry, and national welfare, he must employ general descriptive terms for his analytical results—that is, he must identify types. In identifying and describing generalized types of human activity (cultural design and cultivation practices, for example), one must in a sense lose some of the detail. Only in this way can one see the grander features of a country, and surely only in this way can one develop a comprehensive view of the earth as a whole.

It was once said by a friend of mine that the geographer tries to bite off the world, but can he chew it? It takes long and hard study and an extremely keen appetite, as well as far-reaching curiosity and sustained eagerness of spirit, to carry a geographer to the point where he understands some of the major features of human relationships. In attaining this distant and high goal the maps and the statistical tables available are tools of the first importance. I like to think that the Hispanic-American map serves these great interests as well as the diverse disciplines of history and social science and geography. I like to think that it does so by its high standards of compilation, its faithful interpretation of available data, and finally, and not least, its aesthetic quality.

A significant feature of the Millionth sheets of Hispanic-America is the relative reliability diagram, introduced by the American Geographical Society. In 1928 I had the pleasure of sitting on an international committee on the Millionth Map which formally adopted the relative reliability diagram as a standard feature of the Millionth Map of the world. It is this diagram chiefly which distinguishes a scientific map. It tells how much we do not know and the degree of accuracy of that which we do know concerning the cartography of a given sheet. I hope the time will come when commercial maps will carry this feature, telling the reader the truth about the little we know concerning the less well-known parts of the world. The highest purpose of the relative reliability diagram, if I may put it paradoxically, is to lead to new surveys that will destroy the sheet upon which the diagram appears.

And now, having indulged me with respect to the hard core of purpose and use that marks the Millionth Map, will you let me take the lid of unemotional scientific control off my mind and indulge my imagination? The patch of color on the map of western Bolivia represents not merely marsh and water on the fringes of sheltered Lake Poopó, but also a vast flock of flamingoes which, in the soft light of sunset, give a shade of pink to the landscape. The rocky islets off the seacoast toward the northwest represent the tradition of one of the Indian romances of pre-Colombian days near the site of ancient Pachacamac. The caps of white that mark permanent snow are not mere meteorology, they are associated with the legendary gods of shore and mountain, fighting in deadly rivalry around the snowy peaks and storming at each other in the thunderheads that form on the flanks of the western cordillera. This trail does not represent the route of a modern pack train only; it represents Almagro marching into Chile.

The shores that front us represent the Spanish Main, and the blue is not merely a blue designed by Mr. Hoen, master engraver of Baltimore, who reproduced the drawings of the map. It is the primeval blue, the enchanting blue, of the Caribbean to which Lafcadio Hearn gave immortality. Dull the eye that cannot discern Orellano's rafts on the wide and muddy Amazon. There is a symbol on the map for Cartagena, but who can hear that name pronounced or see its letters on a map and not remember its walls and massive forts, the fighting and the jungle, and the storied enmity of Spaniard and Englishman? Not only Tehuelches and sheepherders but also Darwin and Hatcher have walked over those distant Patagonian plains. Freebooters, priests, and conquistadores should be sketched on all the borders of Hudson's Purple Land. In short, the map reflects human strife and greatness as well as a surveyor's drawings: we are in the presence not of first-class cartography alone but of great art and history.

The lines on the map, the colors and symbols, are visual representations of field measurements and contribute a systematically analyzed record of surveys reduced to a common scale. But they are more than this: they are inciters of the imagination that bathes all records with interest. Yonder island cape is no "sterile promontory" but the point of land around which de Quiros steered his little squadron as he set his course westward from Callao across the unknown Pacific, a venture hardly second to that of Columbus in boldness. The dark-brown color layers represent not merely a mountain chain but also an upthrust of the oldest sea-remembering rocks in South America. The green patch on the coast of northeastern Perú represents more than a marine terrace and a playa. Here the bird hosts gather at night, and we hear their cries and flutterings today precisely as they were heard

by Pizzarro's men as they staked out their cavalry in the chaparral on their first night ashore.

Besides its use in settling boundary disputes, the map has provided underpinning for field expeditions. It was in amazingly wide use in wartime and was ready for the emergency because the Society had the forethought to begin it long before the anticipated need arose.

I will not apologize for our interest in its use in wartime, however much we prefer the instruments and arts of peace. It is no small thing to contribute to success at arms when the objects in view are honor and freedom in a world that, only four short years ago, was all but lost to dishonor and slavery. It is through freedom tempered by discipline that the finest social gifts of civilization have come. Through freedom in America we have made a unique contribution to education, in the promotion of which this map and its large accessory activities have given direct impetus. Men who make contributions to freedom through the ages tend the eternal light of a universal humanity, and they ask no recognition except understanding, by those who come after, that their candles may be lit at the same altar.

If the Map of Hispanic America were not a part of all of these things, it would not have deserved 25 years of work by a devoted staff of compilers, draftsmen, cataloguers, and geographers, as well as collaborators and friends. Nor would it have justified the cost, for money abstracted from use today is money with a curse on it if it be not returned to human use tomorrow.

Congratulatory Address

Spruille Braden

Assistant Secretary of State, Washington, D.C.

WE DO NOT KNOW how the present efforts of government to cope with our daily problems may appear to future generations. Of this, however, I am certain: the completion of the Millionth Map, under the direction of the American Geographical Society, will in the long perspective be regarded as a great constructive achievement. Concluded in the midst of international chaos, it represents the indomitable determination of men to know and to master the world in which they live. It represents the forces of civilization advancing in spite of high barriers. It will stand as a permanent monument to the spirit of man. . . .

Having lived a good portion of my life among the peoples of the other American republics, for whom I acquired the deepest respect and affection, this map of their countries has a special meaning for me. Out of infinite detail honestly assembled and plotted, your Society has here set down a record of geographical realities. So those of us who have been privileged to dwell with the peoples of those countries have in our hearts and minds an appreciation of their rich culture and of their human values. For my part, I treasure the experience and am guided by it.

This Millionth Map, whose conclusion we are here to celebrate, represents a great cooperative undertaking. It is the product of active and constructive collaboration by scientific institutions, by government bureaus, by industrial organizations, and by individuals throughout the American republics. The moral is clear. Progress, the enlargement of knowledge, the achievement of human security, all call for the constructive and determined collaboration of nations, of organizations, of individuals everywhere. We do not live alone, and we cannot succeed alone.

Just as it is impossible for one man alone to make such a great map as this, so it is impossible for one single element in the nation alone to bring about relations of lasting friendship with the people of another nation. That, too, can come only from the countless threads of individual and collective association, woven together in an intimacy that brings warmth into human relationships.

That is the kind of foreign relations which we, the United States, desire to have. We cannot have it except as we respect ourselves and our obligations, at the same time respecting others and their rights in the same fashion that we expect them to respect us and our rights. We must seek to understand them as we hope they will understand us. We must never forget that intolerance begets intolerance, and that if we wish tolerance from others, we must first nourish it in ourselves. In these ways we shall gain friends and benefit ourselves by helping others. The guiding principle, in these matters, must always be reciprocity. That is the root of all friendship.

As a former mining engineer who has roamed in the Andes and through the jungles of South America, I can appreciate, not only the vastness of the cooperative undertaking represented by the Millionth Map, but the dangers that had to be faced in gathering the requisite information. You geographers will prob-

ably recall what Plutarch said of your far-distant predecessors—that they crowded into the outer edges of their maps the parts of the world about which they knew nothing, merely adding a note: "What lies beyond is sandy deserts full of wild beasts," or "blind marsh," or "Scythian cold," or "frozen sea." Now, in order to give the world the 107 sheets of this map, you geographers have adventured into "what lies beyond." At the cost of personal peril and hardship, you have gone out into the unknown and vanquished and charted it. I find no legendary deserts, "full of wild beasts," in the margins of *this* map!

I say I am not altogether unfamiliar with the kind of difficulties that confronted those who gathered the data for this map. To illustrate these from personal experience, I vividly recall one exploration camp, Sulfatos, 15,000 feet up in the Chilean Andes, where 31 years ago more than half of our 200 workers, my superintendent, and I were all snow-blind at the same time. We were beset by blizzards, snow slides, and every impediment possible to our work. Five of our men went insane in three months.

I know, too, that the hardships of the jungle are equally great. There are accounts of how an entire regiment was eaten up by the tropical forest, except for two men who finally emerged on the other side of the continent. Even today, in the Catatumbo Jungle of Colombia, there are wild Indians, the Motolones, hunting with bow and arrow, who every year attack and sometimes kill workers at oil-producing operations there—and this occurs, so to speak, just over the hill from modern cities displaying an advanced civilization. These conditions form part of the picture behind the 107 sheets and add glory to the achievement.

If I allow myself to speak from experience of the practical difficulties that were overcome, I think I can allow myself to speak with still greater assurance, from personal experience, of the practical consequences that must follow the making of this map. "Morality," said Herbert Spencer, "knows nothing of geographical boundaries." However that may be, practical statesmanship—as Dr. Bowman can well testify—is confronted by geographical boundaries at every turn of the road. During the three years of negotiating to put an end to warfare in the Chaco, one of the greatest obstacles we faced was the lack of any adequate maps. The most accurate of the maps on which we had to depend was as much as 60 kilometers out in some places. I recall the occasion when we mediators received from one of the parties to the dispute three or four maps we had not seen before. We mentioned this to the representative of the other party, who promptly replied: "Oh, if it's maps you want, I'll give you plenty." Within the week, we had received 150 maps, all of them different! In point of fact, the settlement in the Chaco was influenced by the natural features of the terrain, since we set the final boundary in such a way that 130 kilometers of desert, completely arid, would serve as a natural barrier to reinforce it.

The practical point I make here, however, is that, had accurate and authoritative maps been available in the past, one cause of international misunderstanding in this hemisphere might have been eliminated, thereby reducing loss of life and all the other horrors of warfare.

The lack of good maps has been behind many disputes in the Western World, although I am informed that there are still about a dozen instances in this hemisphere of boundaries that remain undelimited or at least undemarcated. This, thanks in great part to the geographers, is a rapidly disappearing cause of international differences.

Such differences breed fears and suspicions that are always likely to become exaggerated out of all proportion. If there is one thing I learned from the protracted negotiations of the Chaco settlement, it is that mutual fear and suspicion between contiguous countries, especially when their armies are facing each other at close quarters, make war all but inevitable.

The development of transportation and communications has now brought all the continents and countries of the earth into close quarters, facing one another, armed with weapons of hitherto unimagined range and destructive power. To ignore any source whatsoever of fear and suspicion, under such circumstances, would be to court catastrophe. Now the principal, I may almost say the universal, source of fear and suspicion is simple ignorance. Therefore, it is imperative that statesmen see to it that the vast areas of ignorance still existing in the world—the "sandy deserts full of wild beasts"—be transformed into areas of knowledge. They must plot every river and stream, every contour in the landscape of international relations. They must achieve detailed, accurate, and comprehensive knowledge based on the scientific approach exemplified by the cartographers. Responsibility for the spread of knowledge falls on every nation, but especially on such a power as the United States, with its vast resources.

We, the United States, are committed by our basic principles and by international agreements not to use our power to subvert human freedom or human rights anywhere. On the contrary, we must use all the influence that our power gives us to encourage human freedom and promote respect for the basic rights of man in the world. This attitude is nowhere more

clearly illustrated than in our conduct under the Good Neighbor Policy and its corollary policy of nonintervention.

In respect particularly of the policy of nonintervention, we are and must be especially sensitive. No one will particularly fear the intervention of the small and the weak, but the very fact of great size and strength arouses fear of what might happen should we be tempted to resort to intervention. To illustrate how careful we must be, I quote the following pertinent statement by Mr. Sumner Welles, which occurs in his *The time for decision*: "The United States recognition," writes Mr. Welles, "of a new government which comes into being through extraconstitutional methods in some other American republic is generally interpreted in the rest of the hemisphere as an indication of approval of the policies and composition of the regime. There is consequently implicit in the act itself under existing conditions at least a suggestion of intervention."

It must be quite evident to anyone who has dealt with these problems that nonintervention cannot be negative either in concept or in practice. It is affirmative and positive by the very nature of things, since whatever we refrain from doing and whatever we refrain from saying may constitute intervention to the same degree as anything we actually do or say. We can dishonor our commitments to the cause of human freedom and to the principle of nonintervention equally by inaction as by action. If this were not so, then nonintervention would be a means for defeating the cause of freedom and encouraging the growth of tyranny. Surely this is not what is meant by nonintervention! I say we must be especially sensitive, in view of our great power, to our obligation of nonintervention. We must lean backwards. But we must lean backwards for the purpose of avoiding intervention by action and by inaction alike.

The problem we face is not how to avoid using our power. We cannot possibly avoid using it, for it weighs in the balance just as much even when we do not deliberately apply it or when we deliberately seek to avoid applying it. Not to use our power may be, in actuality, to *misuse* our power. The danger is equally great. To my mind the conclusion is inescapable that if a nation has great power, as we have it in abundance, it cannot shun the obligation to exercise commensurate leadership.

Leadership, exercised positively by us on behalf of human rights, is an obligation we must accept. Our own freedoms, our own way of life, our own democratic form of government, all depend on it. As you cartographers prepare your maps, scientifically and with infinite pains, so must our statesmen chart the course which leads to peace in the world, to human security, and to the permanent realization by mankind of its noblest aspirations. To do this, we must replace ignorance by knowledge. Whatever the difficulties and perils, we must prepare a millionth map of statesmanship to guide us in every field of international endeavor—social, economic, and political. In short, by emulating the splendid work of this great institution, the American Geographical Society, we can march forward to meet the future with confidence.

Scanning Science—

The suggestion has been made that in our large cities skiagraphic institutions should be erected and equipped, to which physicians or surgeons could send patients, and where, under their direction, pictures of the desired portion of the body could be prepared, just as a physician now writes a prescription which is sent to the druggist to be compounded. Our large hospitals where numerous accident cases are brought should have in the near future a plant sufficient to prepare skiagraphic reproductions at short notice.

Dr. Selle and Dr. Neuhauss have exhibited in Berlin colored photographs which have attracted much attention. They are said to be taken by the method used by Mr. Joly of Dublin, three specially prepared plates appropriate for green, red and blue lights respectively being used. The process has been simplified and the time of exposure shortened. Mr. Frederick Ives exhibited before the Royal Photographic Society of London, on February 25th, his stereopticon showing colored pictures.

—6 March 1896

Technical Papers

Deposition of Calcium Phosphates Accompanying Senile Degeneration and Disease

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The substance of certain pathological calcareous concretions or plaques variously found in the lachrymal duct, prostate gland, and the walls of bronchial tubes and arteries has been loosely described as "phosphate and carbonate of lime," "earth of bones," "earthy phosphate mixed with carbonate of lime," and, more generally, simply as calcium phosphate, ever since the time of the first description by Wollaston in 1797. The question whether the carbon dioxide found on the chemical analysis of such materials is present as admixed carbonate or as an integral part of a single phase has been uncertain. Investigations in recent years by X-ray diffraction and optical methods have failed to show admixed calcium carbonate and phosphate in bone and teeth, however, and it is now generally held that these deposits consist of a substance with an apatite-type structure that contains constitutive carbonate ion. It may be noted that tricalcium phosphate hydrate, $Ca_3(PO_4)_2 \cdot nH_2O$, gives an X-ray powder diffraction pattern similar to that of apatite and is isomorphous therewith. Carbonate can enter this compound, as in apatite. The material can be distinguished (*2*) from hydroxylapatite, $Ca_{10}(PO_4)_6(OH)_2$, by heating to *ca.* 900° C., where it breaks down to β-$Ca_3(PO_4)_2$, whitlockite, and then gives the X-ray pattern of that substance. On the other hand, apatite, specifically including carbonate-apatite, and whitlockite give an unchanged pattern after such treatment.

By chemical, optical, and X-ray studies we have identified carbonate-apatite as the principal inorganic salt in the pathological calcification of tuberculous lymph nodes and subcutaneous hematomata. A concretion obtained from a chronically infected prostate gland was found to be composed of fine-grained carbonate-apatite together with crystals of struvite, $NH_4MgPO_4 \cdot 6H_2O$, and an unidentified substance. Brushite, $CaHPO_4 \cdot 2H_2O$, also has been reported in prostatic deposits. Calculi removed surgically from the sublingual salivary glands in several patients were identified as carbonate-apatite. We have also found that the common plaques developed in arteriosclerosis of the aorta and other large arteries, composed largely of cholesterol, frequently contain a small amount of carbonate-apatite. The occurrence of an apatite-like substance was earlier noted by Saupe and Klötzer (*5*) in aortal concretions and by Huggins and Bear (*4*) in prostatic calculi. The "calcium phosphate and carbonate" reported in tonsillar and pancreatic calcifications probably is carbonate-apatite. The latter has also been reported as a common constituent of calculi in the kidneys and urinary bladder by Frondel and Prien (*1*).

A variety of whitlockite containing a small amount of carbonate and analogous to carbonate-apatite was identified as composing a small pathological calcification of the appendix testis or hydatid of Morgagni. This substance also has been found as calculi in the urinary tract. We have not found tricalcium phosphate hydrate in any pathological calcification so far examined, although Hendricks and Hill (*3*) point out that the available evidence indicates that it is the principal constituent of bone.

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Rate of Enzymic Digestion of Proteins as a Factor in Nutrition[1]

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The principal factors which determine the value of a food as a source of protein are (1) its protein content in relation to total solids, (2) the essential amino acid composition of the protein, and (3) the availability of these essential amino acids for tissue protein anabolism. It has been found (*5*) in studies with protein hydrolysates that the omission of a single essential amino acid from an otherwise adequate mixture results in poor utilization of the absorbed

[1] The material in this report constitutes part of a paper presented by one of us (B.L.O.) before the Section on Food and Nutrition, Gibson Island Conference of the American Association for the Advancement of Science, July, 1945.

amino acids. If the missing amino acid is injected separately eight hours after the basic mixture is administered, the retention of amino acid nitrogen is not improved. The working hypothesis in the present study states that for optimum utilization of food proteins all essential amino acids must not only be available for absorption but must also be liberated during digestion *in vivo* at rates permitting mutual supplementation.

Of the various methods for biologically estimating the nutritive value of proteins, one of the best is the nitrogen balance method of Mitchell (*11*). This procedure demonstrates, but does not explain, why a given protein may show differences in biological value after heat treatment even though its ultimate amino acid composition and degree of digestibility remain unchanged. By supplementing the bio-assay technic with the *in vitro* digestibility procedure described in this report, the probable basis for this phenomenon can be elucidated.

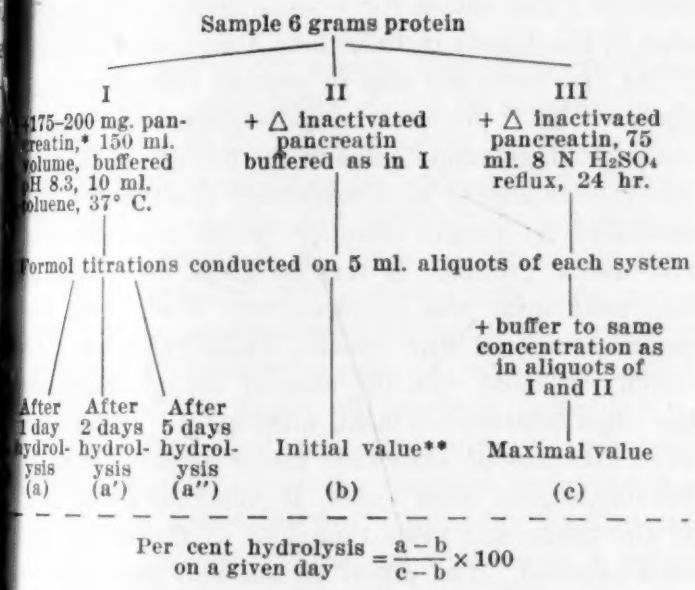
Sample 6 grams protein
I
II
III
175–200 mg. pancreatin,* 150 ml. volume, buffered pH 8.3, 10 ml. toluene, 37° C.
+ Δ inactivated pancreatin buffered as in I
+ Δ inactivated pancreatin, 75 ml. 8 N H2SO4 reflux, 24 hr.
Formol titrations conducted on 5 ml. aliquots of each system
+ buffer to same concentration as in aliquots of I and II
After 1 day hydrolysis (a)
After 2 days hydrolysis (a′)
After 5 days hydrolysis (a″)
Initial value**
Maximal value
(b)
(c)
Per cent hydrolysis on a given day = (a − b)/(c − b) × 100

FIG. 1. *In vitro* technic for estimating susceptibility of proteins to enzymic digestion.

* Quantity of U.S.P. pancreatin dependent upon potency of preparation.

** Includes the titration of the free amino groups in the intact proteins plus the titration of the buffer.

The *in vitro* method involves periodic measurements of the degree of hydrolysis of the protein by a modified formol titration procedure. The details of the method are presented in Fig. 1. The use of suboptimal quantities of pancreatin permits digestion to proceed for several days at 37° C., thus retarding the liberation of the amino acids to reveal differences in rate of digestibility.

Details of the formol titration conditions will be reported elsewhere. Suffice it to say that the titrations were terminated at pH 9.5, instead of pH 8 to 9, yielding values for formol titratable nitrogen in closer agreement with total nitrogen; pancreatic activity was standardized; naturally present enzymes were inactivated and bacterial action prevented; and finally, amide nitrogen and fat were not interfering factors under the conditions employed.

Correlation of the results obtained by this empirical *in vitro* test with more than 30 biological assays of five different sources of food protein has emphasized the value of supplementing the biological data with evidence on the susceptibility of these proteins to enzymic digestion. The animal experiments involved both nitrogen balance studies with the rat and growth studies with both the rat and the chick.

Soybean protein is especially suited to the study of the above-stated hypothesis, since it shows no change in amino acid composition or in degree of digestibility before and after various types of processing, but exhibits marked differences in biological value (retention of absorbed nitrogen).

The data in Table 1 show that those factors known (*12*) to increase the nutritive value of the soy protein also affect the susceptibility of the protein to enzymic digestion. Dry heating of soy flour at 100° C. at atmospheric pressure, or heating the meal in boiling water, induces no improvement in the biological value of its protein. However, autoclaving causes a pronounced increase. It will be noted that with more effective autoclaving treatments the susceptibility of the soy protein to enzymic digestion increased progressively until a plateau in values was reached. Improvement in biological value due to the method of manufacturing soy grits was evidenced by the greater degree and rate of digestibility of the original material.

TABLE 1

SUSCEPTIBILITY OF SOY PROTEINS TO ENZYMIC DIGESTION

Sample (protein content)	Laboratory processing	Hydrolysis of proteins		
		After 1 day	After 2 days	After 5 days
		Per cent		
Solvent-processed soy flour (52.7%)	None	8	9	11
	100° C., 7 days, atmospheric pressure	8	9	11
	in water, 100° C., 5 min.	7	9	11
	Autoclaved 10 min. at 5 lbs. pressure	9	10	14
	Autoclaved 10 min. at 10 lbs. pressure	12	21	24
	Autoclaved 30 min. at 10 lbs. pressure	14	23	29
Expeller-processed soy grits (48.7%)	None	16	20	24
	Autoclaved 10 min. at 10 lbs. pressure	20	23	29
	Autoclaved 30 min. at 10 lbs. pressure	22	27	33
	Autoclaved 30 min. at 15 lbs. pressure	18	25	34
	Autoclaved 45 min. at 15 lbs. pressure	16	25	33

Almquist and collaborators (*2*) and Hayward and Hafner (*8*) demonstrated that the limiting amino acid

in soy protein is methionine and that heating under pressure increases the availability of this amino acid. The fact that it is the rate rather than the extent of liberation of the methionine in soy protein which determines the biological value of soy protein is evident from the illustrative data in Table 2. Using the nitrogen balance technic described by Mitchell (*11*),

TABLE 2

RATE OF ENZYMIC LIBERATION OF AMINO ACIDS DURING THE *in Vitro* TEST OF PROTEIN DIGESTIBILITY AS A CRITICAL FACTOR IN DETERMINING NUTRITIONAL RESPONSE

Experiment		Raw soy meal	Processed soy meal
Rat assays			
Biological value of the proteins, per cent		53	71
Coefficient of digestibility of the proteins, per cent		81	84
Dietary methionine unabsorbed, per cent		49	47
In vitro enzymic hydrolysis of proteins (a)			
After 1 day, per cent		11	14
After 2 days, per cent		16	25
After 5 days, per cent		22	37
Amino acid composition of the proteins (b)			
Leucine, per cent		7.1	7.7
Lysine, per cent		5.1	5.4
Methionine, per cent		2.2	2.2
Liberation of amino acids (c)			
Leucine	per cent, after 1 day hydrolysis	28	33
Lysine		45	56
Methionine		5	10
Leucine	per cent, after 5 days hydrolysis	52	65
Lysine		77	84
Methionine		36	73

(a) Based upon liberation of free amino groups, as determined by formol titration.
(b) Analyses on acid hydrolyzed samples, values calculated to 16 per cent nitrogen.
(c) Includes not only free amino acids but also peptides, liberated during the *in vitro* enzymic hydrolysis and not precipitated by 7 per cent trichloroacetic acid. The values listed are percentages of the total.

it was found that the protein in the raw soy had a biological value of 53 per cent as compared with the value of 71 per cent for the heat-processed soy meal.[2] The coefficients of digestibility of the proteins were approximately the same, 81 and 84 per cent, respectively. Calculations based upon the methionine (*1, 10*) intake, the metabolic fecal excretion of the amino acid, and the total fecal methionine excretion indicated that in both cases approximately one-half of the dietary methionine was not absorbed from the gastrointestinal tract. This constitutes a specific case where degree of digestibility of the protein in the gastrointestinal tract as well as the extent of absorption of the limiting amino acid, methionine, are unchanged, but, nevertheless, the biological value (retention of absorbed nitrogen) varies considerably.

The *in vitro* digestibility tests indicated a marked difference in the susceptibility of these proteins to enzymic digestion. This would indicate that during digestion *in vivo* the methionine is released earlier from the heat-processed soy meal than from the raw soy meal. Eventually the same amount of methionine is released and absorbed from either product. However, in the case of the raw meal, absorption occurs so late in the intestinal transit that this amino acid, as well as the incompletely supplemented amino acids, are not efficiently utilized for the synthesis of body protein.

The validity of this interpretation is supported by further experimental findings. The proteins of the raw and processed samples were analyzed for three amino acids, leucine,[3] lysine (*4*), and methionine (*1, 10*). Practically the same values were obtained for both products, in agreement with the values reported in the literature for soy protein (*3*). The deproteinized filtrates obtained in the course of the *in vitro* enzymic hydrolysis of protein, at the end of the first and fifth days, were also subjected to amino acid analysis. The values for leucine, lysine, and methionine in the digests include these amino acids not only in the free state but also in peptide linkage not precipitated by 7 per cent trichloroacetic acid. Hence the percentage amino acids in the filtrates of the protein digests should be considerably greater than that estimated by formol titration which measures only free amino groups. It may be noted (see Table 2) that methionine was liberated very slowly from raw soy as compared with leucine, while lysine was most rapidly released. In the case of the processed soy the same relationship held, although all amino acids were liberated at somewhat faster rates. When the five-day digests were tested, it was found that most of the lysine and more than half of the leucine had been released. The digest of the heat-processed soy meal contained twice as much methionine as that of the raw meal. These data indicate that methionine is liberated at a slower rate than the leucine or lysine in soy protein and that heat processing increases the rate of liberation of the methionine to a relatively greater extent.

This concept of rate of liberation of methionine supports observations made by others in studies with soy protein. Johnson, Parsons, and Steenbock (*9*) have reported negligible decreases in fecal sulfur and nitrogen when raw soy meal is replaced with a properly cooked product. However, greater retention (decreased urinary excretions) of both these factors was noted when the heat-processed soy meal was fed. These observations are in complete harmony with the hypothesis presented in this report, since they, too, indicate no increase in methionine absorption when

[2] The proteins were included in the diet to the extent of 9 per cent of the ration. Adult male rats were employed for the assays.

[3] Composite of the methods of S. Shankman. *J. biol. Chem.*, 1943, **150**, 305; and J. R. McMahan and E. E. Snell. *J. biol. Chem.*, 1944, **152**, 83.

the heated soy is ingested but, under such circumstances, better utilization of this as well as the other amino acids. More recently, Evans (*6*) reported no correlation between the "digestible" organic sulfur content of soy protein and its nutritional value.

The present studies, conducted with soy protein, have been extended to oats, milk, and other proteins and have yielded similar data indicating that the rate of release of individual amino acids during enzymic digestion can readily account for differences in the biological value of the proteins. However, some precautions must be exercised before rating a sample with maximal digestibility as the most acceptable. For example, excessive heat processing of soybean meal can lead to destruction of some amino acids, so that the biological value becomes the resultant of two factors: (1) the improved digestibility of the protein, leading to greater retention of the absorbed nitrogen, and (2) the imbalance in essential amino acid composition, responsible for a lowering of the biological value of the protein.

On the basis of the present findings it might seem that protein hydrolysates should be superior in biological value to the original intact proteins. In the case of the former, the amino acids would be liberated *in vivo* very rapidly and therefore be available for absorption almost as a group. However, the recent report by Woolley (*13*) indicates that there may be one or more essential peptides which the animal organism is unable to synthesize. It was found that the omission of the factor, strepogenin (presumably a peptide), from a dietary containing a hydrolysate which furnished all of the essential amino acids in satisfactory quantities was responsible for the poor biological response. Thus, in addition to a proper balance of the essential amino acids, it may be necessary to insure certain peptide linkages in the dietary for satisfactory utilization of amino acid nitrogen.

Addendum: The report by Ham and associates (*7*), which appeared while this paper was in press, suggests that the effect of heat on a proteolytic inhibitor in soybean is responsible for the differences in susceptibility of soy protein to enzymic digestion. However, the impairment in utilization of the protein derived from raw or improperly heat-processed meals must be attributed to an inhibition of the *rate* of methionine liberation for mutual amino acid supplementation and not to a reduced *degree* of methionine availability as postulated by Ham and collaborators.

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A "Frenching" Response of Tobacco Seedlings to Isoleucine

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Growth of tobacco seedlings in aseptic cultures under constant light and temperature was found to be greatly modified by the presence of isoleucine in the culture medium. The abnormalities in gross morphology resulting from the addition of this amino acid consisted in loss of dominance of the apical bud, production of numerous quite narrow leaves, and mottled chloroses. The shortened stem and excessive development of axillary buds gave a "witch's broom" type of growth. The abnormalities enumerated are characteristic of a tobacco disease called frenching, the cause of which is unknown.

Slight variations from the symptoms of frenching in the field were observable under the extreme environmental conditions employed. These abnormal conditions were very high moisture and relative humidity, low light intensity, and the use of agar instead of soil. The mottling of the leaves was not of the reticular pattern typical of frenching, nor did the narrow or strap-leaves assume the upright position to the same degree. There was little indication of wavy margins or ruffling of strap-leaves.

These abnormalities occurred regularly in every experiment with several samples of this amino acid. None of the other amino acids, sugars, vitamins, and peptones (a total of 60) tested brought about this reaction. The severity of abnormal symptoms varied with the concentration of isoleucine employed. Levels of 50 to 200 p.p.m. proved adequate under these conditions. Complete details of the experimental work will be reported later.

Additional work is now under way in both greenhouse and field to determine the degree in identity of symptoms under normal conditions of growth for tobacco. Data are also being sought to aid in determining whether the response of the tobacco plant to isoleucine is of a primary or secondary nature. Secondary causatives of this type have already been reported by McMurtrey (*1*) as thallium and Spencer (*2*) as sulfanilamide.

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On the Specificity of Epidemic and Murine Typhus

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That the rickettsiae of epidemic and murine typhus are closely related antigenically is shown by the fact that infection of guinea pigs with epidemic typhus confers complete immunity to infection with murine typhus and vice versa. That they are, however, not antigenically identical has been shown by the following observations: (a) Immunity induced with one inoculation of killed murine rickettsiae protected guinea pigs only against infection with the homologous type, although repeated inoculations of the same vaccine also immunized against the heterologous type (*7*). (b) Serum obtained from a horse after one series of inoculations with killed murine rickettsiae protected guinea pigs only against infection with the homologous type (*8*) although serum from the same horse after a second series of inoculations with the murine vaccine protected guinea pigs against both homologous and heterologous types (*9*). (c) Purified rickettsial suspensions reacted in complement-fixation tests only with homologous convalescent human and guinea pig sera, although the corresponding "soluble antigens" reacted with both homologous and heterologous sera (*5*). (d) Absorption of sera from cases of Brill's disease with murine antigen removed murine but not epidemic antibody, although epidemic antigen removed both murine and epidemic antibody (*4*). (e) Sera obtained from guinea pigs immunized with murine and epidemic typhus vaccine, respectively, neutralized only the homologous toxic substance (*6*).

The specificity of epidemic and murine typhus has been further demonstrated by the active immunization of mice in the experiments described below. Murine (Wilmington strain) and epidemic (Breinl strain) typhus vaccines were prepared from heavily infected yolk sacs[2] and two groups of 50 mice[3] each were immunized with one intraperitoneal inoculation of 0.5 cc. of epidemic and murine vaccine, respectively. Fourteen days after inoculation half of each group of immunized mice was challenged with homologous and the remainder with heterologous toxic substance (*1, 3*). The challenge dose, consisting in each case of 0.5 cc. of toxic substance, representing 3 to 4 LD_{50}, was injected intravenously in the tail vein. The results, recorded 18 hours after challenge, are presented in Table 1. It

TABLE 1

Specificity Shown by Active Immunization of Mice

Challenged I.V. with 0.5 cc. of:	Vaccinated I.P. with 0.5 cc. of:		Controls	
	Epidemic typhus vaccine	Murine typhus vaccine	Toxic substance diluted: 1–20	1–40
Epidemic toxic substance diluted 1–10 (3 to 4 LD_{50})	20/23*	0/23	0/10	8/10
Murine toxic substance diluted 1–10 (3 to 4 LD_{50})	1/23	22/23	0/11	7/10

* Number of mice surviving/total number of mice.
I.V.—Intravenously.
I.P.—Intraperitoneally.

will be seen that 20 of 23 mice immunized with epidemic typhus vaccine and 22 of 23 mice immunized with murine typhus vaccine were protected against 3 to 4 LD_{50} of the homologous toxic substance. Furthermore, none of 23 mice immunized with murine typhus vaccine and only one of 23 mice immunized with epidemic typhus vaccine was protected against the heterologous toxic substance. It is evident from these data that one inoculation of epidemic or murine typhus vaccine protected mice only against the homologous toxic substance.

Summary: The specificity of epidemic and murine typhus has been shown by active immunization of mice with killed rickettsial suspensions and subsequent challenge with heterologous and homologous toxic substance.

During the preparation of this manuscript, Fitzpatrick published findings showing that 3 of 8 mice immunized with murine typhus vaccine were protected against 3 MLD of epidemic toxic substance administered intravenously and that 8 of 16 mice immunized with epidemic vaccine were protected against <1 MLD of murine typhus rickettsiae administered intraperitoneally (*2*). These results suggested to Fitz-

[1] On temporary leave from the Division of Microbiology, Squibb Institute for Medical Research.

[2] National Institute of Health, Washington, D. C. Communication on the preparation of epidemic typhus vaccine, 10 August 1942 (confidential).

[3] Young albino Swiss mice (Webster strain) weighing 12-13 grams were used throughout these experiments.

patrick that the toxic factor in the two strains is identical. Although there are antigens common to both strains, our findings do not support the suggestion that the two toxic substances are identical.

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The Target Area of Mammalian Red Cells

ERIC PONDER

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When a suspension of N red cells is placed in a beam of parallel light, its opacity depends in a complex way on the projected area, or "target area," which the cells present in the direction of the light (*3*). As extreme cases, all the cells might be oriented edge-on, or all face-on, and in the former case the opacity would be less than in the latter because the target area is smaller. When the cells are oriented at random, the target area, T, is somewhere between these two extremes. Although the mammalian red cell is a biconcave discoidal body, all its possible projections in a beam of parallel light are those of a similar discoidal body in which the biconcavities are replaced by two planes, one on each side of the cell, passing through the circles of points along the greatest thickness of the rim. We can thus obtain a simple solution of what has been hitherto a troublesome problem by using a little-known theorem which was proved by Cauchy and to which attention has recently been called (*1*): If a body is convex and has area A, A is equal to four times the mean of the area of the projection of the body on a plane for all orientations of the latter. To find the target area of a suspension of red cells oriented at random, we have therefore to find the area, A, of a body of the same shape as that of the average red cell, except that the biconcavities are replaced by the planes described; the target area, T, will then be equal to $NA/4$.

Computations of A have been made from scale drawings of the average red cells of several animals (*2*), using Pappus' theorem for the surface of a solid of revolution. The values are given in Table 1, which also gives the values of S, the surface area of the biconcave discoidal red cell.

The ratio A/S varies from 0.88 to 0.91 in these five types of red cell, and, while the mammalian erythrocyte is by no means constant in shape in all species, it is probably good enough for the purposes of opacimetry to take A as equal to 0.9 S.

TABLE 1

Cells of	A, μ^2	S, μ^2
Man	144	163
Rabbit	100	110
Elk	71	79
Sheep	60	67
Tahr	24	27

The target areas corresponding to the *spherical* forms of the red cells of man, the rabbit, and the sheep are $N \times 25\,\mu^2$, $18\,\mu^2$, and $12\,\mu^2$, respectively.

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Soil Nitrogen and Thrips Injury to Spinach

S. H. WITTWER and LEONARD HASEMAN

University of Missouri

That the nutritive qualities of agricultural crops are influenced by the fertility of the soil on which they are grown is a well-established fact. Also, that a relationship exists between soil fertility and the production of plants resistant to, or unsuitable as food for, insect pests has been demonstrated by recent work at the Missouri Agricultural Experiment Station (*2*). Some of the possibilities in this as yet little explored field of entomology have recently been suggested by a striking relationship observed between the amount of soil nitrogen provided for spinach plants and their "resistance" to attack by the common greenhouse thrips (*Heliothrips haemorrhoidalis*).

New Zealand spinach was grown under controlled conditions in gallon glazed crocks using colloidal clay cultures (*1*). A series of 16 soil treatments was prepared by supplying calcium and nitrogen levels each of 5, 10, 20, and 40 milliequivalents per crock with all possible (*i.e.* 16) combinations in these amounts of the two nutrients. Each series was replicated 10 times. Calcium acetate and ammonium nitrate were the respective sources of the variable elements, and all other nutrients were provided in constant amounts for all treatments. The plants were placed in a greenhouse infested with thrips, the insects being left free to choose whatever plants they wished. During the first

month of growth, of the 320 plants in the experiment, not one of the 160 plants grown at the two higher nitrogen levels was noticeably attacked by the insect. This condition was in sharp contrast to that observed on an equal number of plants grown at the two lower nitrogen levels, of which practically all were seriously damaged. It was also of significance that when the calcium supply was increased, the insect attacks on the low-nitrogen groups were less serious.

As the same plants matured and the transition from vegetative to reproductive development was initiated, an unexpected phenomenon characterized the feeding habits of the thrips. In the two lower calcium series they shifted from the plants grown on soils low in nitrogen to those highest in this nutrient, while the damage in the higher calcium groups practically ceased for all treatments. As a result of greater vegetative growth, the plants with low calcium and originally supplied with adequate nitrogen had probably approached the unbalanced nutritional status characteristic of those provided with the least nitrogen at the beginning, since no additional nutrients had been added during the course of the experiment. The insects invariably selected as food those plants of a lighter green color. Even on the same plant, the thrips always chose the older, more mature leaves in preference to those younger and higher in nitrogen. In general, as long as the crops made a vigorous luxuriant growth as a result of an adequate nitrogen supply, they were practically immune from insect attack.

For a proper interpretation of these observations, one should be mindful of the following items of interest: (a) most insects have specific hosts, signifying, perhaps, that they have definite food requirements to satisfy; (b) the nutrient contribution of the host plant may be altered tremendously by soil fertility, especially, as in this case, when the nitrogen is varied (3); (c) the long-recognized value of crop rotation in pest control may be, in part, a result of better maintenance of soil fertility and consequent greater "plant resistance"; (d) the explanation as to why some crop pests, such as codling moth, become more serious as fruit trees are grown continuously on the same soil without a complete renewal of the nutrients removed may be found, in part at least, in soil deficiency; and (e) possibly the continuing need for the creation of new insecticides to hold in check greater and more destructive ravages of insect pests is aggravated by the gradual, but general decline in soil fertility from year to year.

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Obituary

D. F. J. Lynch
1891-1945

Final rites for D. F. J. Lynch, director of the Southern Regional Research Laboratory of the Bureau of Agricultural and Industrial Chemistry, U. S. Department of Agriculture, were held in New Orleans, Louisiana, on 16 October 1945.

Mr. Lynch, a native of Boston, Massachusetts, died at his residence on 15 October 1945 following a week's illness. He was 54 years old.

Widely known as a chemist, Lynch came to New Orleans six years ago when the Southern Regional Research Laboratory was built. He had been connected with the U. S. Department of Agriculture for twenty years and had gained fame for developing a method for the production of cellulose from sugarcane bagasse.

Lynch was chairman of the Louisiana chapter, American Institute of Chemists, a member of the American Chemical Society, and an active member of the Army and Navy Club of New Orleans. He was a veteran of World War I.

In 1934–35, Mr. Lynch supervised the construction and operation of a semicommercial plant in Hawaii for the production of cellulose and in 1938 directed a survey of research being carried on in the Southern States by federal, state, and private laboratories on industrial utilization of agricultural commodities. Prior to assuming his post at the New Orleans laboratory, Mr. Lynch directed the U. S. Government By-Products Laboratory at Ames, Iowa.

He received his A.B. and A.M. degrees in chemistry from Harvard University and LL.B. and LL.M. from the Georgetown law school in Washington, D. C.

JOSEPH T. HOGAN

U. S. Department of Agriculture

News and Notes

Dr. Walter J. McNamara has been made consultant in educational tests and measurements in the IBM Department of Education. Dr. McNamara will serve as director of educational research for the entire IBM educational program. His services will also be available to educational institutions for professional consultation on problems and procedures in test scoring and educational evaluation.

Dr. Robert B. Jacobs has joined the staff of Distillation Products, Inc., Rochester, New York, where he will direct the work of the physics laboratory, which is concerned with the study of physical phenomena at low pressures.

Hobart E. Stocking, for the past year visiting professor of geology at the University of Costa Rica, has joined the staff of the New Mexico Bureau of Mines and Mineral Resources at Socorro as geologist and editor. His work will include the preparation of a series of popular articles on New Mexico's geology and mineral industry.

Dr. Ellinor H. Behre, on leave for a semester from Louisiana State University, occupied the position of visiting research professor at the Colegio Agricultura of the University of Puerto Rico at Mayaguez. Dr. Behre was engaged in studies of marine invertebrate life histories, especially those of Crustacea.

Dr. Donald Wilson Hastings, former chief psychiatrist of the Eighth Air Force in England and later chief air force psychiatrist in Washington, has been appointed by the University of Minnesota Board of Regents as professor and head of the Department of Neuropsychiatry in the Medical School. Dr. Hastings will fill the vacancy left by the illness and resignation of Dr. J. Charnley McKinley.

Dr. E. Willard Miller has been made associate professor and chief of the Division of Geography at Pennsylvania State College.

W. W. Grigorieff has been appointed director of the ORDARK Project at the University of Arkansas, Fayetteville. He was formerly laboratory section head at the General Electric Company in Pittsfield, Massachusetts.

Dr. Albert Frederick Bickel has joined the Department of Research in Pure Chemistry at Mellon Institute as the recipient of a postdoctoral fellowship for one year of study offered by the Institute to an organic chemist of Dutch nationality. In that capacity Dr. Bickel, who was selected by the Netherlands Ministry of Education, will continue with advanced organic investigation, and it is expected that the grant will aid him in becoming familiar with recent scientific progress in the United States and with new American research techniques.

Dr. Frederick J. Moore, of the Department of Experimental Medicine, University of Southern California, is actively engaged in a study of heteropolar antiseptics in general surgery. His work is supported in part by a research grant in the amount of $5,000 from the Medical Research Division of Sharp and Dohme.

Dr. Loyd E. Harris has been made professor of pharmaceutical chemistry at the College of Pharmacy, Ohio State University. Dr. Harris has recently returned from the second of two tours of overseas duty, where he served with chemical warfare intelligence and made a survey of the German chemical industry.

Olaf P. Bergelin, captain in the Corps of Engineers and recently associated with the Manhattan District, has been appointed assistant professor of chemical engineering at the University of Delaware. Dr. Bergelin will take over immediate direction of a cooperative research project on heat exchangers.

Dr. Ismael Vélez, principal botanist of the Institute of Tropical Agriculture, at Mayaguez, Puerto Rico, while on sabbatical leave of absence from Polytechnic Institute, San German, is leaving for Venezuela with Mr. Ventura Barnes, Jr., on an exploration trip to the Amazonas region.

Dr. Edwin T. Mertz, biochemist, has been appointed assistant professor of agricultural chemistry at Purdue University. For the past three years he has been a research chemist at the Hercules Powder Company Experiment Station, Wilmington, Delaware.

Dr. A. E. Alexander, formerly with the B. G. Corporation, New York City, has assumed directorship of the Gem Trade Laboratory, Inc., 608 Fifth Avenue, New York City. This laboratory, designed primarily for the testing of pearls and precious stones, is supported by the leading gem and pearl dealers of New York.

Dr. William H. Griggs of Kirksville, Missouri, has been made an assistant professor of pomology at the University of Connecticut, Storrs.

William G. Hoyt, Interior Department, has been elected chairman of the Executive Committee of the

American Society of Civil Engineers' hydraulic division.

Capt. Ralph Decker Bennett, USNR, has been awarded the Legion of Merit for outstanding services while attached to the Naval Ordnance Laboratory in Washington, D. C. Capt. Bennett, who left Massachusetts Institute of Technology to begin active duty in the Naval Reserve in 1940, is technical director of the Laboratory.

The presentation was made only a few days after Capt. Bennett had been awarded the decoration of Honorary Officer of the Military Division of the Most Excellent Order of the British Empire—twentieth highest of 124 decorations authorized by the Crown. The NOL scientist, who spent a number of months at United Kingdom laboratories during the war, received the award from Ambassador Lord Halifax at the British Embassy in Washington.

Naval Ordnance Laboratory is the Navy's headquarters for the design and development of mines, depth charges, and assorted underwater weapons. Its research scope will be further extended when the Laboratory is moved into the new $15,000,000 science campus at White Oak, Maryland, later this year.

Announcements

The first invention in 200 years involving a new projection to show the map of the world on a flat surface was patented by R. Duckminister Fuller, Wichita engineer, on 30 January 1946.

Awards amounting to 10,000 pounds were made in London on 22 January to the three scientists who discovered and developed penicillin. According to *The Times,* Sir Alexander Fleming received 5,000 pounds, and Sir Howard Florey and Dr. Boris Chain, his two co-workers, received 2,500 pounds each. They were recently jointly awarded the 1945 Nobel Prize for medicine. The gifts were from a 25,000-pound trust fund created in 1924 by Sir Harold Harmsworth and his father, the late Sir Leicester Harmsworth, to encourage research into the causation and treatment of infective endocarditis. Lord Horder made the presentations at a luncheon given by Sir Harold Harmsworth at the Savoy Hotel.

The Meritorious Service Plaque was awarded to the Army Institute of Pathology on 7 February. The director of the Institute is Col. J. E. Ash.

The American Society of Mechanical Engineers, through its Committee on International Relations, has issued an appeal to engineers throughout the country to assist with gifts of technical books and periodicals to replace those lost or destroyed in war-devastated areas. Donations of money will be used to buy new books for foreign technical libraries.

To spend eight months studying jungle life in Venezuela, Dr. William Beebe and the staff of the New York Zoological Society's Department of Tropical Research sailed on 10 February for the Society's field station at Rancho Grande, Venezuela. The expedition will make its headquarters in 18 rooms of a huge, unfinished concrete building in a forest west of Caracas, at an elevation of 3,500 feet. The surrounding area is a national park and abounds in mammal, bird, reptile, and insect life. The expedition was scheduled to arrive at Rancho Grande on 18 February. This is the department's second expedition to Rancho Grande.

An Annual Review of Microbiology will be published by Annual Reviews, Inc. The Review will be similar in format and in organization of subject matter to the *Annual Review of Biochemistry* and the *Annual Review of Physiology.* The new Review will appear under the direction of an editorial committee consisting of Drs. Monroe D. Eaton, Department of Public Health, Berkeley, California; Wallace E. Herrell, Mayo Clinic, Rochester, Minnesota; C. B. van Niel, Hopkins Marine Station, Pacific Grove, California; J. M. Sherman, Cornell University, Ithaca, New York; E. C. Stakman, University of Minnesota, St. Paul, Minnesota; and W. H. Taliaferro, University of Chicago.

Prof. Charles E. Clifton, Stanford University, has been appointed as editor, and Profs. Sidney Raffel, Stanford University, and H. A. Barker, University of California, will serve as associate editors. The first volume is expected to appear in November 1947.

George Washington University has established a Department of Geography. Dr. Louis O. Quam will direct the department, with Dr. Myron L. Koenig, dean of the junior college, as associate professor. Dr. Robert W. Richardson, of the State Department's office of research and intelligence, has been appointed professorial lecturer.

Dr. Kenneth W. Vaughn writing in the Fortieth Annual Report of the Carnegie Foundation, says: "Unless the college has definitely fixed its objectives, formulated the means proposed for attaining them, and specified the results expected from the use of such means, it is extremely difficult to ascertain to what extent progress is being made."

The Sinai Hospital of Baltimore announces the establishment of the Alfred Ullman Laboratory for Neuro-Psychiatric Research. The work in the laboratory will be carried out under the direction of Dr. H. S. Rubinstein.

The Pharmacology Department of the School of Medicine, University of Georgia, has announced grants totaling $5,400 for the year 1946 from Frederick Stearns and Company, Eli Lilly and Company, and Ciba Pharmaceutical Products, Inc. These funds are to support fellowships and technical help in investigating the pharmacology of the uterus in pregnancy and dysmenorrhea. One of these fellowships will be available in September 1946 with opportunity for the fellow to take part-time medical work.

The Perkin Medal for outstanding achievement in the field of industrial research was awarded to Dr. Francis C. Frary, director of research, Aluminum Company of America, on 11 January for "distinguished additions to the chemistry of aluminum." The award was made at a dinner at the Hotel Commodore, given by the Society of Chemical Industry, with the American Chemical Society, the American Institute of Chemical Engineers, the Electro Chemical Society, and the Société de Chimie Industrièle participating.

The Perkin Medal, according to *The Christian Science Monitor,* which reported the event, was founded in 1906 in commemoration of the fiftieth anniversary of the coal-tar color industry. The original medal was awarded to Sir William H. Perkin, who was the first to find out how to produce an artificial dyestuff. This dye led to the foundation of the coal-tar color industry of today. The medal is awarded annually to any chemist residing in the United States for distinguished services to the chemical industry.

Dr. Frary is the fortieth recipient of the medal and the second chemist on the staff of Aluminum Company to be so honored. In 1911 Charles Martin Hall was given the medal for his development of the present-day process for the manufacture of aluminum. Some of the other recipients of the medal include: Dr. E. G. Acheson, who discovered artificial graphite and carborundum; Dr. Leo H. Baekeland, a pioneer in synthetic resins, and after whom bakelite is named; Dr. Irving Langmuir, whose name is associated with the gas-filled tungsten lamp; Dr. Thomas Midgley, Jr., who gave us ethyl gasoline; and Dr. E. K. Bolton, under whose direction neoprene and nylon were developed.

A comprehensive gynecology survey of women in Texas state institutions is being organized under the direction of Dr. Willard R. Cooke, professor of obstetrics and gynecology at the University of Texas Medical Branch, Galveston, and his associate, Dr. John W. Weaver. This survey is being made in cooperation with the State Board of Control, Judge Weaver Baker, chairman. It is supported by a three-year grant of $20,000 from the Lilly Research Laboratories of Indianapolis.

The Graduate Record Examination, sponsored by the Carnegie Foundation for the Advancement of Teaching, has now entered its ninth year. More than 6,500 students took the Examination at 208 educational centers, including 11 in Canada, during the past year. The number of complete scorings made in the last seven years exceeded 45,000. The Examination was extended to 98 higher institutions, a gain of about 35 during the year. All of these required or invited applicants for admission to graduate or professional study to submit results of the Examination as auxiliary credentials. More than one-third of the total number of institutions require the Examination of some or all classes of applicants.

The Examination, essentially a test of the student's knowledge over broad fields of subject matter, measures achievement in mathematics, physics, chemistry, biology, social studies (including history, economics, and government), literature, and fine arts. A verbal factor test is required. Advanced tests are available in major fields of specialization. Results are presented graphically in profiles, which reveal the standing of the student as to individual accomplishment and as a member of the tested group.

The Examination is under the direction of Dr. William S. Learned.

The Carnegie Foundation for the Advancement of Teaching reports that among the 67 educators and scholars receiving retiring allowances from the Foundation who died during the year ended 30 June 1945, 17 were in their eighties, two were in these nineties, and one died at the age of 100 years, 7 months, and 1 day.

The University of Utah School of Medicine announces the following additions to its staff: Dr. Randolph T. Shields, formerly surgery resident at the University of Pennsylvania, and more recently Major in the U. S. Army Medical Corps in the China-Burma-India Theater, has been appointed instructor in surgery. Dr. Crichton McNeal, now stationed at the Army Institute of Pathology in Washington, D. C., has been appointed instructor in pathology. Dr. David W. Morgan, now at the Regional Hospital, Camp Swift, Texas, has been appointed clinical instructor in psychiatry.

The University of Colorado announces that field courses in geology and biology will again be offered at Science Lodge, the University's high-altitude mountain laboratory in the Colorado Rockies. The work will be given in two terms, 17 June to 19 July, and 22 July to 23 August. Courses in geology will be provided for beginners, intermediate, and advanced students. In biology the courses will be largely for intermediate and advanced students. For information, write to the Dean of the Summer Quarter, University of Colorado, Boulder, Colorado.

During the 1914–1918 war 34,000,000 maps were printed, but during World War II, between January 1941 and September 1944, 230,000,000 were manufactured, according to Major C. A. Hart, deputy assistant director of the Military Survey, who spoke recently at the Royal Geographical Society, London, on "Modern Maps and How They Are Made." He said that the British issued 9,500,000 maps of North Africa alone before the landings there. The big problem in mapping was presented by areas in the enemy's hands in the Far East, of which there were almost no reliable maps. Great advances in the technique of surveying by air making use of planes fitted with radar and special recording devices were made in this area. Major Hart felt that the application of radar to aerial surveying will reduce the cost of aerial photographic surveying by as much as 50 per cent.

Wyeth, Inc., has made a grant of $6,000 a year to Dr. Franz R. Goetzl of the Department of Medical Research of Permanente Foundation, Oakland, California for experimental and clinical studies in anaphylaxis and clinical allergy.

A new Department of Geography was established as a separate instructional unit at Northwestern University in the Fall of 1945. Prof. G. Donald Hudson is chairman of the new department while William E. Powers and Harold Ward, formerly members of the Department of Geology and Geography, have joined the new department. Three new appointments, Clarence E. Jones, Edward B. Espenshade, and Clyde F. Kohn, were also made. Prof. George Kiss, of the University of Michigan, will give a summer session course in Political Geography and a graduate seminar in the Geography of Europe.

Forty winners in the Fifth Annual Talent Search, conducted by the Science Clubs of America and administered by Science Service, attended a dinner at the Hotel Statler, Washington, D. C., on 5 March 1946. The event culminated an entire week in which the high school students had attended the Science Talent Institute. From the 40 winners one boy, Jules Alfred Kernen, 16, of St. Louis, and one girl, Marilyn Rohrer, 17, Elizabethtown, Pennsylvania, were awarded the four-year $2,400 Westinghouse scholarships.

Eight additional contestants were awarded $400 each and 30 were awarded scholarships of $100 each for one year. The forty winners had survived successive hurdles in selection which separated them from more than 16,000 original contestants from the 9,200 science clubs in the United States.

Albion College has acquired by gift and purchase 300 acres of land near Battle Creek to serve as its Biological Preserve. Dr. A. M. Chickering outlined extensive new opportunities for field work and observation on such problems as taxonomy of plants and animals, ecology, soil analyses, studies in the character of lake bottoms and other geological features, plankton studies in the Preserve's three small lakes, ornithology, protozoology, surveying, and forest mensuration. The Preserve includes the following types of ecological regions: second-growth upland hardwood, tamarack swamp, lowland hardwood, lowland brush, sedge and grassy marshland, bramble, lake aquatic, meadow herbaceous, a small sphaguum boggy region, and a small moraine running in a sinuous manner through the property.

At the last meeting of the Association Canadienne Française pour l'Avancement des Sciences, the Leo-Pariseau's medal was awarded to Mr. Paul-A. Giguère, of the Department of Physics of Laval University, according to Jacques Rousseau, general secretary of the Association.

A grant of $5,000, in support of clinical research conducted by Dr. C. Gordon Johnson, has been made to the Department of Gynecology, Tulane University Medical School, New Orleans, Louisiana, by the Medical Research Division, Sharp and Dohme, Inc.

Columbia University, College of Physicians and Surgeons, is the recipient of a research grant in the amount of $2,200 from Sharp and Dohme, Inc., in support of Dr. Erwin Brand's work on proteins and amino acids.

The College of Medicine of the University of Tennessee announces the following changes in the clinical staff. Dr. E. C. Mitchell becomes emeritus professor of pediatrics, to be succeeded by Dr. F. T. Mitchell as professor and head of the department. Dr. James G. Hughes has been promoted to associate professor of pediatrics and will devote full time to the department.

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The Southern Section of the American Society for rticultural Science held its first postwar meeting at w Orleans on 5–7 February. The following officers re elected for 1946–47: Dr. B. L. Wade, chairman; r. Otis Woodard, vice-chairman; and Dr. J. B. lmond, secretary.

The Anthropological Society of Washington an- unced the following officers for 1946 following a eeting on 15 January: Dr. Regina Flannery, Cath- ic University of America, president; Mr. H. W. rieger, U. S. National Museum, vice-president; Dr. illiam N. Fenton, Bureau of American Ethnology, ecretary; Dr. Waldo R. Wedel, U. S. National Mu- um, treasurer; and Dr. W. M. Cobb, Howard Uni- rsity; Dr. W. H. Gilbert, Jr., Library of Congress; r. Margaret Lantis, U. S. Department of Agricul- ure; and Dr. J. H. Steward and Dr. G. R. Willey, mithsonian Institution, councilors to serve on the oard of Managers.

Conditions Abroad

Sergei Vavilov, president of the Academy of Sci- nces of the USSR; Igor Tamm, director, and Pavel herenkov, a scientific worker at the Lebedev Physics nstitute; and Alya Frank, also of the Academy of ciences have been awarded Stalin prizes, it was an- ounced in Moscow on 27 January. It is said that the rizes are considered to be the domestic equivalent f the Nobel prize. The dispatch noted that Peter apitsa and A. Joffe, two leading physicists, were not mong the recipients this year because they had been warded the prizes previously.

Prof. Jean Firket, Institute of Pathology of the niversity of Liège, 1 Rue des Bonnes Villes, Liège, elgium, writes that the Institute has escaped major amage but that part of the equipment is missing. r. Firket is reviewing the literature on cancer re- earch and would greatly appreciate receiving from merican scientists reprints bearing on the fields of ancer research and pathology.

Cytologists who have lost track of their European colleagues may find the following addresses of help. They have been obtained through the assistance of Dr. Meitès and of the former Office of War Information:

Dr. Marc Meitès, chargé de recherches au Centre National de la Recherche Scientifique, and M. le Professeur J. André Thomas are both at the Institut du Radium, 26 rue d'Ulm, Paris (5e). Others are: M. Pierre Gavaudan, Laboratoire de Biologie Cellulaire, Centre d'Etudes du Bouchet, Le Bouchet par Vert-le-Petit, (Seine et Oise) France; Dr. Paul Sentein, 1 Place de la Comedie, Montpellier, (Hérault) France; Gunnar Östergren, Fil. lic., Lunds Universitets Inst. för Ärftlighetsforskning, Lund, Sweden.

A letter from Prof. Josef Kisser, plant physiologist and morphologist at Vienna, has been received by Dr. Irma M. Felber, Michigan State College. He says that shortly after the occupation of Austria he was dismissed from his post of full professor at the Hochschule für Bodenkultur, but was granted a small pension which hardly sufficed to support his wife and three children. He managed to continue research as a volunteer at the Biological Experiment Station, although under most unpleasant conditions. He finished several papers before he was drafted in 1941 and sent to the Balkans. In May 1945, after the Russians had occupied Vienna, he resumed his post at the Hochschule, but under great hardship. Since no transportation existed, he had to walk daily two hours from his residence to the Institute. In June classes and laboratory courses started. Now, for the winter term, he has 420 students in his classes and 4 graduates. He also is provisional director of the Botanical Garden and Institute of the University. Prof. Kisser badly misses foreign scientific literature and is asking his American colleagues to send him reprints of botanical papers published since 1941. His address: Hochschule für Bodenkultur, Botanisches Institut, Wien XVIII, Gregor Mendelstrasse 33.

Dr. H. Neumann, Histological Laboratory of the University of Amsterdam, Holland, has written to I. M. Kolthoff, University of Minnesota, urgently requesting that reprints of papers dealing with enzyme-reactions and protein chemistry published during the war be sent to him, since none of this literature is available in Holland.

Prof. Ernst Gaumann, mycologist, Eidg. Technischen Hochschule, Zurich, Switzerland, has written to Dr. L. E. Wehmeyer, University of Michigan, as follows:

> Dr. DeFago was killed in an auto accident. . . . From other countries we know less than you, because we have got the French occupation-zone around us, and this zone is as hermetic as the Russian zone. . . . Anyhow, from the names you ask, Wollenweber is alive, also Pilat. From Cejp and Lohwag I don't know reliable news; I think however, that with Cejp something is wrong. . . . Van Vloten in Holland has lost his wife, who was killed at his side; both his legs were terribly wounded, but there is some hope to get them in order again. Miss Kreitjes has been deported by the Germans. . . . and she has died in a concentration camp. Her sister was deported too; she was released by the Americans, but if I am not mistaken, she has now died too. . . .

In the Laboratory

An Instrument for Determining the Partial Pressure of Oxygen in a Gas[1]

LINUS PAULING, REUBEN E. WOOD,
and J. H. STURDIVANT

The Gates and Crellin Laboratories of Chemistry, California Institute of Technology, Pasadena

In response to a request by the National Defense Research Committee, we developed in the Fall of 1940 a simple and effective instrument for determining the partial pressure of oxygen in a gas. The operation of this instrument depends upon the fact that the magnetic susceptibility of oxygen is very much greater than that of any other common gas: at 20° C. and one atmosphere the volume magnetic susceptibility of oxygen is $+142\times10^{-9}$ c.g.s.m.u., whereas that of nitrogen, which is representative of the common diamagnetic gases, is -0.40×10^{-9} c.g.s.m.u. The magnetic susceptibility of a gas is hence determined almost entirely by the partial pressure of the molecular oxygen in the gas;[2] the effect of adding one atmosphere of nitrogen is equal to that of decreasing the partial pressure of oxygen by 0.0028 atmospheres.

The indication of the magnetic susceptibility of the gas in this oxygen meter depends on the behavior of a small test body surrounded by the gas in an inhomogeneous magnetic field. The force on the test body due to the magnetic field is proportional to the difference in volume magnetic susceptibility of the test body and the gas surrounding it. The operation of the instrument is accordingly analogous to the ordinary determination of the density of a liquid by weighing a solid body suspended in the liquid (Archimedes' principle). The test body in the meter is a small dumbbell consisting of two thin-walled glass spheres about 3 mm. in diameter connected by a small glass rod or tube about 4 mm. long; this dumbbell, which weighs about 2 mg., is cemented, together with a small mirror, to a silica fiber about 3 microns in diameter and about 10 mm. long which is stretched across a silica fork. By rotating around the silica fiber, which serves as a torsion balance, the spheres of the dumbbell may move in an inhomogeneous magnetic field. The field is produced by permanent magnets (usually two Alnico V horseshoe magnets weighing about 5 ounces apiece) with suitably shaped soft iron pole pieces. The magnetic susceptibility of the gas in the chamber (with gas volume about 4 ml.) surrounding the test body may be indicated on a scale by a beam of light reflected from the small mirror.

Several hundred of the meters have been manufactured, the first few dozen by the California Institute of Technology, and the others by Dr. Arnold O. Beckman, 11 West State Street, Pasadena 2, California, who took over the production of the meter in the Summer of 1942. The meter is made in several models for various special purposes and to cover various ranges of partial pressure of oxygen. The precision is dependent on the range; it is, for example, about ±1 mm. of mercury for a meter covering the partial pressure range 0 to 180 mm. of mercury. Some recording models of the instrument are available.

Our principal collaborators in the development of the instrument at the California Institute of Technology were David P. Shoemaker, James B. Edson, Harold Herd, Dr. Herbert Sargent, Dr. Charles D. Wagner, and Beckie Bradford. Professor H. Victor Neher gave us valuable advice and instruction in silica fiber technique.

[1] This work was done in whole under Contract No's. NDCrc–38, NDCrc–200, OEMsr–326, and OEMsr–584 between the California Institute of Technology and the Office of Scientific Research and Development, which assumes no responsibility for the accuracy of the statements contained herein.

[2] The paramagnetic gases, nitric oxide, nitrogen dioxide, and chlorine dioxide, if present, would also contribute largely to the magnetic susceptibility of the gas.

Quantitative Differentiation of Minute Amounts of the Coproporphyrin Isomers (I and III) Based on Fluorescence Behavior[1]

SAMUEL SCHWARTZ, VIOLET E. HAWKINSON, and C. J. WATSON

Department of Medicine, University of Minnesota Hospitals

The coproporphyrin isomers have identical absorption and fluorescence spectra (*1*). Other physical characteristics of differential nature, such as the ester melting point and pH fluorescence curves, require relatively large amounts of crystalline material. The concentration of coproporphyrin in normal and pathological urines is usually in the range of 50–500 γ per 24-hour sample, so that any method which requires crystallization prior to determination of the percentage of isomers in the mixture is unsatisfactory, simply

[1] Aided by grants from the John and Mary R. Markle Foundation, New York City, and the Medical Research Fund of the Graduate School, University of Minnesota.

ause of the time, effort, and expense involved in isolation of crystalline ester. Essentially the same true in the case of feces. For the purpose of lying the excretion of the coproporphyrin isomers health and disease, a relatively simple method was ded which could be applied to small amounts of ne and feces. Some time ago a procedure was cribed which permitted determination of the per-tage of isomers in a mixture of very small amounts). This depended upon a differential elution of the ers from a Tswett column of aluminum oxide. It s found impossible, however, to apply this method urine with uniform results except where the por-yrin ester had first been crystallized. This was true n though several hundred alternative methods of rification, preliminary to the elution, were tried. us, although the method has considerable funda-ental interest and value, it is not of practical use-lness.

The purpose of the present communication is to cord another and hitherto undescribed difference in ysical behavior of the coproporphyrin I and III ers. This consists in a marked difference in rate precipitation in 30-per cent acetone when the range concentration of the total coproporphyrin is from -70 γ per 100 cc. Since as little as 10 cc. of final lution are required, it is evident that the method applicable to the resolution of mixtures of from to 7 γ of total coproporphyrin. The phenomenon characterized by a rapid disappearance of red orescence in Wood's light in the case of the type isomer, while with the type III isomer the disap-earance is negligible within 1½ hours. In this range of concentration the solution is colorless, and the pre-ipitation is not visible. It is probable that the phe-omenon is actually one of colloidal aggregate forma-ion which then proceeds to actual precipitation. Thus, it has been noted that after standing for 1 hour in a 30-per cent aqueous acetone solution, a consider-able amount of coproporphyrin I ester will have col-ected on the sides of the glass tube. At this time the ed fluorescence has disappeared, but if the fluid is poured out of the tube and a small amount of chloro-form is then poured in, the chloroform quickly gains an intense red fluorescence in Wood's light, obviously having dissolved porphyrin ester which had been de-posited on the glass out of the 30-per cent acetone solution.

The data shown in Fig. 1 reveal the striking dif-ference in behavior of the coproporphyrin esters I and III in 30-per cent aqueous acetone at 4° C. The disappearance of fluorescence is slower at room tem-perature. It is apparent in Fig. 1 that the rate of decline of the fluorescence intensity is considerably greater as the concentration increases above 30 γ per 100 cc. Thus at 30 minutes the fluorophotometer read-ing decreased from 150 to 80, with a concentration of 30 γ per 100 cc., while with 60 γ per cent the de-crease at 30 minutes was from 260 to 20.

The distinction of the two isomers on this basis is not an absolute one, since there is also a slight diminu-tion of the fluorescence of coproporphyrin III. The difference in this respect is so great, however, that it permits an approximate determination of the amount of each isomer in a mixture. It should be emphasized that the fluorescence of the coproporphyrin III dimin-ishes more rapidly at higher concentrations, so that these are not suitable for application of the method.

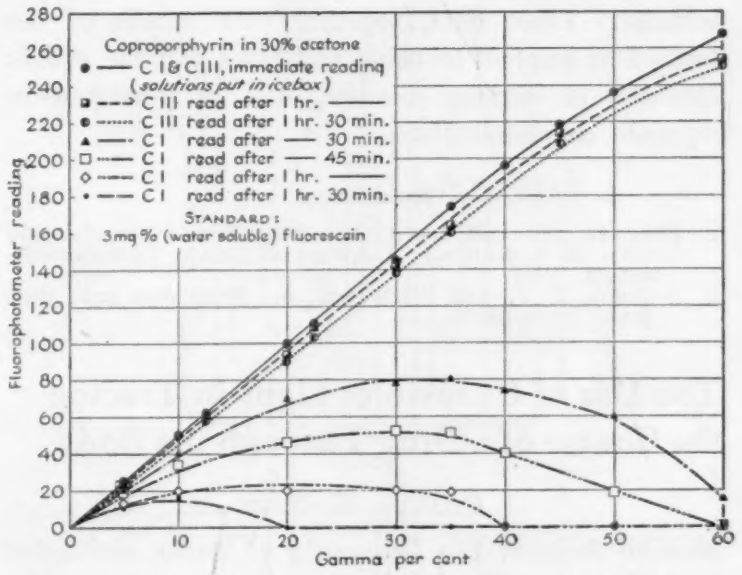

FIG. 1. Fluorescence intensity of the coprophyrin methyl esters (isomer types I and III) in 30-per cent acetone at 4° C. The immediate reading at 0 time was made prior to chilling. The time is constant for all points on each of the curves. The diminution of fluorescence intensity for any given concentration is thus represented by the distance from the 0 curve (immediate reading) to the appropriate curve below.

During the past two years the method has been satisfactorily applied to the coproporphyrin analysis of many 24-hour urine samples, both from normal individuals and in various diseases, 50–250 cc. aliquots being employed for the determination. A considerable preliminary purification is necessary, including ether extraction of the porphyrin from the urine, concentration from the ether by extraction with 5-per cent HCl, methyl esterification, and chromatographic separation of the total coproporphyrin ester on a Tswett column of calcium carbonate, following which the fluorescence intensity in 30-per cent aqueous acetone is measured in a Klett fluorophotometer, using a 3-mg.-per cent aqueous solution of fluorescein as a standard. A reading is taken at once and again after the solution has stood at 4° C. for 1½ hours. The approximate proportions of coproporphyrins I and III in the original mixture are then determined by reference to the data shown in Fig. 1. The validity of the results

for both urine and feces has been confirmed repeatedly by means of isolation of the crystalline ester and determination of its melting point. This, of course, merely establishes the predominating isomer type in the original mixture. No discrepancies have been encountered between this and the differential precipitation method as described above.

In order to avoid the necessity of correction for the small residual fluorescence of coproporphyrin I when its initial concentration is less than 20 γ per cent, and for the slight diminution in fluorescence intensity of coproporphyrin III at all concentrations employed (see Fig. 1), a curve has been prepared for various mixtures of the isomers, reference to which permits determination of the percentage of each in a given mixture. These data, together with details of the method as applied to urine and feces and the results obtained in various diseases, will be described in separate communications.

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The Use of Ultraviolet Light in Tracing the Course of a Drug Through the Body

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Medical Branch, The University of Texas, Galveston and The Marine Biological Laboratory, Woods Hole, Massachusetts

It seems possible, if one takes advantage of the fluorescence of various drugs under ultraviolet light, to trace their course through an animal's body. A timetable of the drug's appearance in the different organs might be set up. The greatest concentration of a drug in, and the disappearance of the drug from, a given organ might be judged by the degree of fluorescence of that organ. This is shown to be true in the case of the quinine derivative, quitenine, which is prepared by oxidizing the vinyl group of quinine to the carboxyl group with a permanganate.

Quitenine was chosen for this purpose because of its intense purple fluorescence and because it can be injected in a fairly sizable dose (2 mM/kg.) without killing the animal. The toadfish (*Opsanus tau*) was used as the experimental animal since considerable knowledge of the action of quitenine on this animal is available (*1*). The drug in doses of 2 mM/kg. as quitenine dihydrochloride was injected subcutaneously into the side of the fish behind the dorsal fin. Sloughs developed at the site of injection in a few days. The fish were killed by a blow on the head and oper just before examination. The source of ultravio light was a Hanovia Chemical and Manufacturi Company Inspectolite, which gives a light of abo 3,660 A.U.[1] All observations were made in a da room, with the eyes well dark adapted.

In visible light there is not any significant differen in the appearance of the viscera of the uninjected a injected fish except that there is more variation in t color of the gall bladder in the injected fish. Und ultraviolet light the organs of the uninjected fi show no fluorescence with the following exception the gall bladder shows a faint yellowish fluorescenc and in some cases the full urinary bladder shows strong white fluorescence.

The injected toadfish were killed at daily interval until they showed no more fluorescence than the uni jected fish, and examined under ultraviolet light. Fo the first six days the markings on the skin are muc more noticeable in the injected than in the uninjecte fish. The injected animal fluoresces, this being esp cially noticeable in the eyes. For the first two day after injection the cut edges of the skin and muscle show marked purple fluorescence as does the mixtur of blood and body fluid that is in the body cavity The gut shows a strong purple fluorescence for tw days and a weaker one the third day. There is n marked fluorescence at the site of injection until slough develops. The slough gives a strong purpl fluorescence until about the seventh day after injectio and then gradually weakens, giving a red fluorescence probably due to some infection. Organs other tha the liver, gall bladder, kidney, ureters, and urinary bladder do not fluoresce with the exception of th ovaries, in which at times the eggs, in injected and uninjected fish, give a brilliant golden fluorescence. This is probably connected with their stage of develop ment and is independent of the drug.

These observations show that when quitenine is in jected subcutaneously into the toadfish it is at first widely distributed throughout the body and that a large part of it is rapidly concentrated in the liver. The kidney is a very dense organ, and it would require a high concentration before any fluorescence would show. This is attained by the fourth day, although the excretion had begun on the second day, as is shown by the fact that the craniad end of the ureter shows a purple fluorescence. The drug in the liver begins to disappear on the ninth day, that organ being practically free of the drug by the tenth day. The concentration in the kidney becomes low also on the ninth day, and in at least some fish the detectable concentration in the urine disappears on the tenth

[1] The writer is indebted to Dr. George A. Lavin of the Rockefeller Institute for Medical Research for the use of his ultraviolet lamp and for much needed advice.

...y, when the craniad end of the ureter is white and ...e caudal end shows a purple fluorescence.

It is shown that it is possible to trace the passage ... a fluorescent drug through the body with the use of ...travioiet light. If the drug were injected intraven...sly it would appear and probably disappear from ...e organs in a much shorter time. Experiments are ... progress to trace various fluorescent drugs in mam...als after intravenous administration.

Reference

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Modification of Metabolism Apparatus[1]

W. JAMES LEACH

Department of Biology, Temple University

Basal metabolism in man is commonly calculated on ...e basis of oxygen consumption. Clinical types of ...esting apparatus are designed for determining either (1) the amount of oxygen consumed during a definite ...eriod of time or (2) the time required for the con...sumption of a definite quantity of oxygen. The prin...cipal advantages in using a clinical type of apparatus ...re in their simplicity of operation and in computa...tion of results. This type of apparatus is, however, ...ot well adapted for metabolism studies that involve ...other than resting or basal conditions. The purpose of this report is to describe a modification of a stand...ard type apparatus to broaden its usefulness in ...studies of oxygen consumption under various condi...tions of activity.

The essential feature of the present modification is ...he inclusion of a regulator valve and rate-meter tube (Rotameter),[2] which is inserted in the oxygen intake ...line of a standard closed-circuit apparatus of the Benedict-Roth type. The setup is shown in Fig. 1. With these additions, oxygen can be delivered at con...stant and measured rates simultaneously with the con...sumption. By adjusting the flow from a predicted demand (from standard tables) to the actual require...ments a direct reading of the consumption can be ...made. In this case the oxygen-consumption line be...comes parallel to a horizontal base line (Fig. 2, line A).

A brief discussion of the data shown in Fig. 2 will illustrate a method of using the apparatus and sug...gest further applications.

[1] I am especially indebted to Mr. George K. Porter, of Hatboro, Pennsylvania, technical authority on Rotameters; to Mr. Harold A. Hopkins, Philadelphia service representative for Benedict-Roth apparatus; and to Mr. Warren E. Collins of Boston, who supplied some of the materials with which a bellows type apparatus (mentioned in text) was constructed.

[2] The "Rotameter" is a flow-rate meter of the "variable area" type. The metering element is a rotating free float operating in a precision, taper-bore tube, which is calibrated to give a direct reading of the rate of flow.

The initial oxygen-consumption line (A) was obtained on a subject by adjusting the flow to 260 cc. O_2 per minute, at which point the delivery and consumption balanced. This amount was delivered at 30 lbs. pressure throughout the test period, and represents the oxygen requirement under resting conditions (after one hour reclining). At (B) the subject was

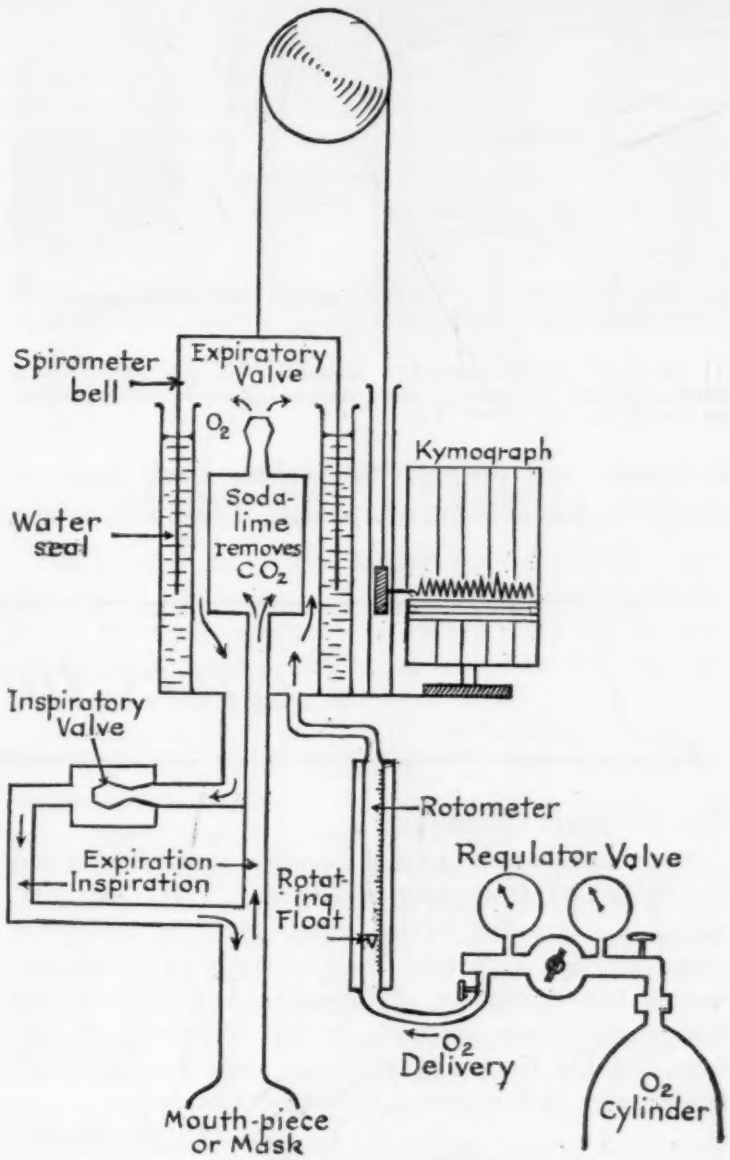


FIG. 1. A diagram of metabolism apparatus of the Benedict-Roth type showing the assembly of the regulator valve and Rotameter.

detached from the circuit, and while prevented from respiratory exchange with outside air, he ran down and up a flight of stairs and then was reconnected into the circuit. The duration and character of the recovery period (payment of oxygen debt) is shown by the curve (C), and the amount of oxygen required for performing the work is represented by the vertical distance between the level of the initial resting line (A′) and the secondary oxygen consumption line (D). The line (D), in leveling off, shows that full recovery has been effected.

Calibrations of the particular Rotameter which we have been using give accurate deliveries within a range

of from 200 to 800 cc. per minute. In this range the float moves through a distance of 125 mm. This

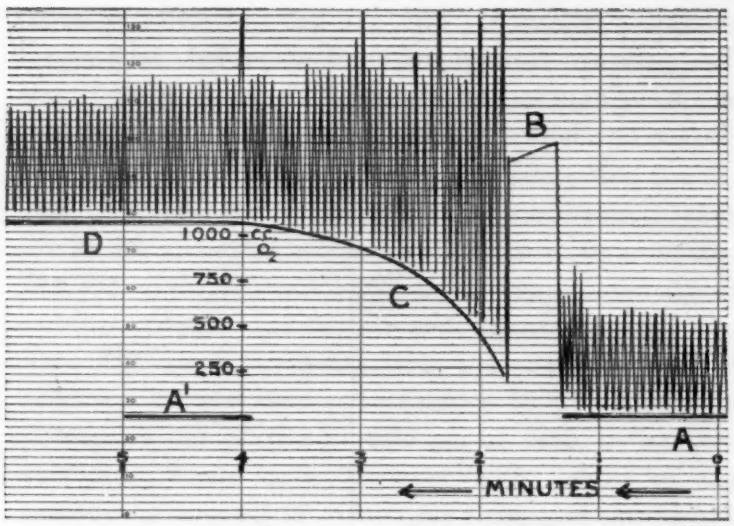


FIG. 2. A kymographic recording of the effect of a stair-climbing exercise on metabolism. Note recovery period as shown by the curve (C).

Rotameter was designed to measure small flows of liquids used in aviation equipment. Obviously, a tube of greater length with a similar range of delivery would aid in more precise reading.

Corrections for temperature and pressure for the Rotameter delivery are negligible and may be disregarded. Such corrections, however, are necessary for gas in the spirometer.

My principal purpose in designing the modification was for use in connection with class work of a course called "Applied Physiology." The report is given here with the thought that investigators more especially interested in metabolism studies may be better able to further develop the present modification. Our experience with the apparatus as shown in Fig. 1 indicates the desirability of redesigning other parts of the apparatus, especially for use with the Rotameter. One modification we have tried is the substitution of a respiratory bellows in place of the water spirometer. This makes respiratory movements much easier on the subject but increases difficulty of computations. Refinements in the construction and assembly of the apparatus would obviously contribute to greater accuracy and also further broaden its application.

Letters to the Editor

The McDonald Observatory

Your announcement of appointments at the Yerkes and the McDonald Observatories (*Science*, 1946, 103, 80), should be corrected to the effect that the McDonald Observatory is a part of the University of Texas and not of the University of Chicago. Appointments for both observatories are made by the University of Chicago, but the University of Texas owns the McDonald Observatory and approves the appointments.

OTTO STRUVE, *Director*
The W. J. McDonald Observatory, Fort Davis, Texas

Museum of Science and Industry

In *Science* (1946, 103, 17) you refer to our sister institution in New York as "The Museum of Science and Industry." This is misleading even though you add the words "Rockefeller Center, New York." We feel, in view of the history of the two institutions, that we are entitled to have our museum associated with that name.

The New York museum was founded under the name of "The Museum of the Peaceful Arts," while ours carried the name "The Rosenwald Industrial Museum." When we changed our name to "The Museum of Science and Industry," they changed to "The New York Museum of Science and Industry." At that time we protested the close copy of our name, but they declined to change, claiming that the qualifying words "New York" made the distinction clear. Certainly, to leave off these words is unfair to this institution, which considers itself entitled to its proper designation before the public. We will appreciate your consideration of this point.

RUSSELL H. ANDERSON
Museum of Science and Industry, Chicago

Malaria and Rainfall Periodicity in Palestine

The war has demonstrated the vital necessity of medico-geographical work. Yet, in order to be useful, it seems to us that future work in this field should avoid some of the pitfalls found in Dr. H. de Terra's "Rainfall periodicity in relation to malaria and agriculture in the Near East" (*Science*, 1945, 101, 629–631).

Studies in medical geography should be based not only on geography, but equally on medicine. Of course, excessive or insufficient regional rainfall is one of the causal factors of malaria epidemics, and such correlations have been attempted since the time of Hippocrates. (A. Hirsch has provided a survey of such attempts, which were particularly numerous about a hundred years ago, in *Handbook of Geographical and Historical Pathology*. London, 1883, Vol. I, pp. 258 ff.) It is not possible, however, to predict malaria epidemics simply on the basis of probable maxima of rainfall, for to do so is to reduce the complicated process underlying a malaria epidemic to one simple factor: the quantity of anopheles. (I. J. Kligler, who is one of Dr. de Terra's main sources, makes the follow-

important strictures on the use of rain statistics in *e epidemiology and control of malaria in Palestine* hicago, 1930): "The importance of rainfall as a factor the formation of breeding places depends as much—metimes more—upon the distribution as upon the total ume" (p. 6). "Most of the anopheles breeding places Palestine are due however either to century old neglect man or to man's carelessness" (p. 11).) We know day that fluctuations in the *immunity* of the population e an essential factor in the genesis of a malaria epimic (L. W. Hackett. *Malaria in Europe.* London, 37, pp. 217 ff.). Fluctuations in spleen mass which press the amount of "immunity" or "premunition" em to offer a far more reliable factor for prediction malaria epidemics than rainfall curves. Preceding ars of drought, which reduce endemicity and therefore remunition, and which break down the cattle barrier, ay in this sense contribute at least as much to an idemic as the rainfall period itself. There are other ssible factors also, e.g. increased gametocyte production, which should be taken into consideration.

In a region such as Palestine, where the rate of malarial fection is always high, the mass importation of nonimunes is likely to be more important in setting off an pidemic than the importation of carriers. This is applicable to the situation in Palestine in 1917 when soldiers, nd to other years when colons and laborers, were moved bout in large numbers. In addition to these, the social dislocations of war bring many other disturbances which re conducive to spreading malaria. It seems more likely hat Greece and the Balkans suffered from similar epidemics in 1917 because of similar sets of causes, some f which were social, than because of "similar rainfall egimes" with Palestine, which they do not have. (Palestine has a typical Mediterranean regime of winter cyclonic ain and summer drought. Except for Greece, none of the Balkans has such a rainfall distribution. The Adriatic coast is an area of high year-round rainfall. The rest of the Balkans, except Greece, are marked by a strong concentration of summer convectional rains.) One should note in this connection that parts of France and Flanders, certainly not similar to Palestine in rainfall regime, also had epidemics in 1917.

The weakness of a unitary explanation of malaria in Palestine is illustrated by the impossibility of predicting malaria in Palestine from de Terra's graph. The graph would, for instance, suggest epidemics at least in 1914 and 1929. But no such epidemics were observed. It will be shown below that the evidence is not good for epidemic malaria in the years noted on the graph. These contradictions can be understood only if all factors contributing to malaria epidemics are taken into account. One of the most important is social change. Even if excessive rain should occur in cycles of 10 to 12 years over the Holy Land, its chances of producing a malaria epidemic would depend largely on its always encountering equally miserable socioeconomic conditions and equally susceptible populations. This, fortunately, is neither necessary nor likely.

These methodological considerations are independent of the validity of the data on epidemics and rain cycles. Unfortunately, the evidence advanced for epidemics in 1904, 1911–12, and 1926 seems inadequate. That Cropper found a high rate of infection in 1904–05 is no reflection of an epidemic in this period, but simply of the fact that he made his inquiry in those years. The same holds good for the data of Bruenn and Goldberg in 1911–12. The epidemic of 1917–19 did not actually conform to rain statistics and stop in 1919, as de Terra assumes, but continued into 1920 and 1921 (see Kligler, p. 157). The data concerning the "epidemic of 1926" which we have been able to collect are far from indicating a "rapid rise of malaria infections" in 1926. For example, G. J. Schneider (*Organisation und Erfolg der Malaria Bekämpfung in Palästina.* Jena, 1928) has collected the following data:

Percentage of malaria cases in all clinic patients		Infections in region supervised by Malaria Research Units
1922	7.17	68.4
1923	4.90	34.8
1924	4.12	13.2
1925	2.27	9.8
1926	2.04	11.0

Spleen index census

November 1925 ..... 4.6 per cent
November 1926 ..... 1.7 per cent

The rainfall cycles are equally open to doubt. The theories of correlation of sunspot maxima and rainfall, and of the cyclic occurrence of rainfall maxima, are too speculative for anyone to be able as yet to interpret unanalyzed curves in accordance with them.

Although de Terra states that for Palestine "meteorologic recordings go back sufficiently in time to permit of definite conclusions as to the periodicity of rainfall and water supply," such periodicity is neither evident in his figure nor demonstrated in his text. He shows rainfall curves for three stations for the years 1874 to 1939 and for the fourth station an unbroken record only from 1920 to 1938. The last is too short to be useful except in comparison with the other curves with which, however, it shows poor correlation. The three long-range stations also show poor agreement with each other. A very wet year at one station is a very dry year at another. It is difficult to see any way of predicting rainfall from such irregular curves.

The agreement with the solar cycles shows the same picture. Wet periods of individual stations occur both at sunspot maxima and minima. One must ask if there is even a rough correlation. De Terra states that he has under way a special study on possible periodic shifting of the cyclonic storm tracts in the Eastern Mediterranean. It is to be hoped he will demonstrate more clearly any periodicity he may find in his data.

It may well be that one of the necessary conditions for a malaria epidemic in Palestine is maximum rainfall. But even if rainfall periodicity could be "better recognized and substantiated," it is unlikely that this alone could "lead to the prediction of conditions conducive to malaria epidemics." No one expects Dr. de Terra to be a malaria expert. We regret, however, both that he did not analyze his climatic data further and that he did not collaborate with other scientists who could have helped him better to

evaluate the role of weather and climate in malaria. Any effort in the field of medical geography is highly desirable, and should be encouraged; but we feel that in order to contribute effectively to a scientific understanding, medical geography will have to study the phenomena in all their complexity and keep clear from premature and oversimplified conclusions.

ERWIN H. ACKERKNECHT, M.D.
GEORGE F. CARTER, Ph.D.
The American Museum of Natural History
The Johns Hopkins University

Supplementary statistical data which I received, after publication of my article, by courtesy of the president of the Hebrew University of Jerusalem, and which are at present not available to me in Mexico, show rather well the relationship between rainfall maxima and peaks of malaria mortality. Even if the data given for previous malaria incidence in Palestine are inadequate, it is nevertheless suggestive to see the epidemics of (if I remember correctly) 1935 and 1939–40 occurring in years of greater rainfall. As for the irregularity of the rainfall cycles, seemingly apparent for certain stations, it must be remembered that such discrepancies may well be due to local microclimatic factors arising out of peculiar topographic location. However, this cannot distract from the general impression of periodicity. As for the cyclic control of these epidemics, it would seem that late spring rains in between the major rainfall peaks possibly introduce another climatic element which deserves further study in relation to malaria epidemics. While it is apparent that present data are suggestive rather than conclusive, I would personally only welcome a fuller investigation of this important problem of medical geography, not only through closer cooperation with medical specialists but through an effective and intensive field study in the Near East. Only thus will it be possible to eliminate the inadequacies disclosed by this discussion.

H. DE TERRA

Mexico, D. F.

Virus Encephalomyelitis in Buffaloes

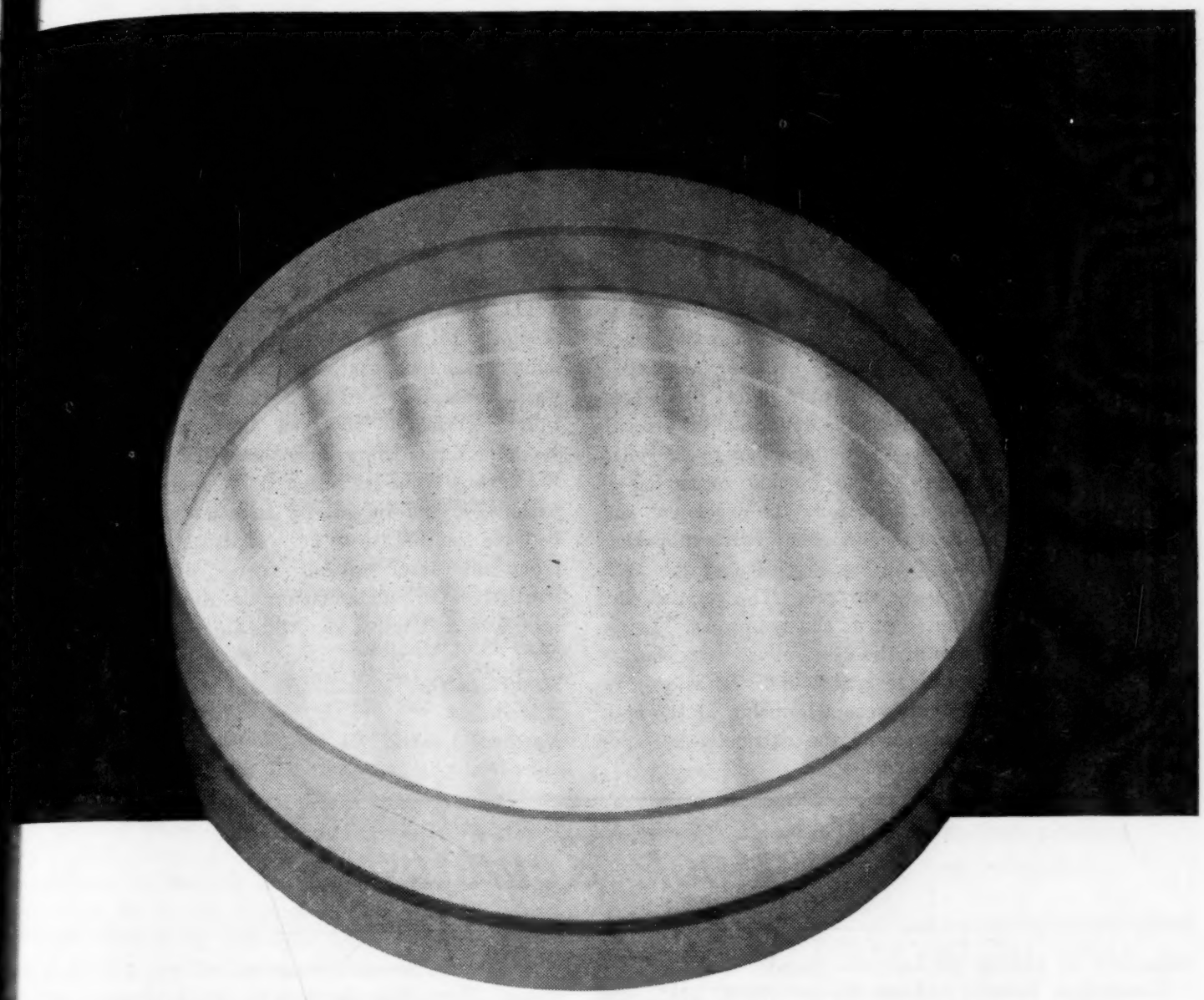
In the western part of the Szechuan province, China, there is a disease among water buffaloes known as "Szegiao-han" (meaning "four-legs-cold") to the farmers. It occurs more in wintertime than in the hot seasons, and young and old buffaloes seem to be equally affected. Its occurrence in other provinces is also suspected, though not proved. A report of the disease in the scientific literature has not appeared before.

Onset of the disease is usually abrupt. The first symptom is a paralysis of the hind legs and inability to stand. The paralysis quickly extends to the fore legs and may be of either a spastic or flaccid type. Animals apparently well the day before may be found lying ill in the stable the next morning with all four legs rigidly extended. The body temperature is usually subnormal from the beginning of the illness. As death approaches, it often drops to below 35° C. Only occasionally is a middle-grade fever observed. The surface temperature of the legs feels colder than normal and thus the name. Sensation of the skin is dulled, especially over the paralyzed parts. In severe cases there is complete anesthesia of the whole body surface except over the head. Appetite and rumination are decreased and later entirely lost. Other rarer symptoms are retention or incontinence of urine, colic pains, bloody discharge from the anus, tremors of the muscles, and rigidity of the neck. The respiratory and circulatory systems are comparatively less affected. Consciousness is retained and excitement absent. The course of the disease is usually short, most animals dying within one to two days. The mortality rate is very high (probably over 95 per cent.).

On post-mortem examination, the central nervous system is usually found to be highly congested. There may be hemorrhages under the meninges and petechiae in the spinal cord. The cut surface of the brain, however, looks apparently normal. Occasionally there is a gelatinous infiltration in the epidural space of the vertebral canal. Besides these changes in the nervous system there are always signs of septicemia of the whole body. Hemorrhages may be found in different organs. Constant and especially marked are hemorrhagic gastroenteritis, cystitis, tracheitis, and endocarditis, and occasionally effusions in the serous cavities. The parenchymatous organs show signs of albuminoid degeneration. Cultures taken from the blood and central nervous system are invariably negative.

Histological examination of the central nervous system reveals congestion and capillary hemorrhages in addition to the petechiae already visible to the naked eye. The nerve cells of the brain and spinal cord are mostly degenerated. The cytoplasm may be either swollen or, more often, shrunken so that the cells become irregular in contour. The nucleoli are masked by the deep staining of the pyknotic nuclei. In some cells there is complete dissolution of the nucleus and tigrolysis of the Nissl substance. The degenerated nerve cells are soon invaded by glial cells. This phenomenon of neuronophagia is especially marked in the pyramidal cells of the cerebral cortex and hippocampus, but less so in the Purkinje cells of the cerebellum and ganglion cells of the spinal cord. Perivascular spaces of the blood vessels of the brain are often dilated owing to an accumulation of edematous fluid. Adventitial proliferation is frequently seen, but perivascular infiltration is rarely encountered. There may be a mild degree of gliosis in the brain substance. Occasionally a small artery under the pia mater is thrombosed. Otherwise, the meninges are essentially negative. Inclusion bodies, whether intracytoplasmic or intranuclear, are not found.

In view of the facts stated above, the author believed this disease to be an encephalomyelitis caused by a filtrable virus. Experiments were soon planned and conducted to test its transmissibility to other animals. Brains and spinal cords of two buffaloes which had died of the disease were ground up in sterile normal saline and filtered through Seitz E. K. filters. The bacteria-free, clear filtrates were injected into goats, guinea pigs,



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rabbits, pigeons, mice, a buffalo, and a sheep. Although the results in the sheep, mice, and pigeons were not sufficiently consistent to warrant a conclusion, the disease was found to be definitely transmissible to the rest of the experimental animals. A similar encephalomyelitis could be produced in the buffalo and goats by intravenous inoculation and in guinea pigs and rabbits by intracranial inoculation. Serial passage, however, was possible only for three generations in the guinea pig and two generations in the rabbit and goat. In the case of the buffalo, extensive experimentation was prohibited by its high cost, but judging from the typical symptoms and severe lesions produced in the only buffalo used, serial passage in this animal seemed to be easier than in any other host.

The incubation period among the experimental animals varied from 1 to 58 days and was shortest in the goat. The experimental disease in the buffalo resembled in every respect the natural infection. It developed suddenly on the twelfth day after injection, with subnormal temperature, paralysis of the legs, rigidity of the neck, and anesthesia of the body surface. The animal died about 14 hours after the onset of the symptoms. In the other animals, the course of the disease was even shorter, most of them dying within several hours. Invariably included among the symptoms were a lowering of the body temperature and a paralysis of the extremities. Upon histological examination, encephalomyelitic changes w always present. Cultures of the blood and cent nervous system have never yielded any bacterial grow

Attempts to cultivate the virus were not successf Chick embryos of 8–10 days were inoculated on allantoic membrane according to the method of Burn The birds seemed to be little affected by the virus a were hatched just as usual. Whether the titer of virus had increased in the embryos was, however, determined.

The disease seemed to be nontransmissible to hum beings. In areas where the disease is prevalent, human case has ever been reported. In our experimen work, the author and his assistants have never worn a rubber gloves or observed any other precautions, a yet none of us has ever contracted the disease.

Judging from its seasonal incidence, symptomatolog pathology, and infectivity to other animals, the auth believes the disease to be a separate entity and differe from all other known forms of encephalomyeliti Further experimentation on the disease is still in pro ress, and a detailed report is in preparation.

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Book Reviews

Principles of physics III: optics. Francis Weston Sears. Cambridge, Mass.: Addison-Wesley Press, 1945. Pp. viii + 331. (Illustrated.)

The first course in physics at the Massachusetts Institute of Technology requires two years and is taken concurrently with analytical geometry and calculus. The result is that the present volume and the two earlier companion volumes of Sears' *Principles of physics* series, which serve as texts for this course, are far above the usual one-year elementary text in scope, rigor, and detail. Indeed, this book promises to be a competitor to the usual intermediate texts in optics, and will probably be considered in this connection by schools whose physics majors have not had the benefit of a first course as thorough as that at M.I.T.

It has much to recommend it. The unconscious technical slang and conventions of the usual textbook presentation are here carefully translated into operational meaning. Well-chosen plates (on color and on diffraction), and three-dimensional line drawings which have a rare feeling for space and projection, aid in setting a new standard in clarity of explanation. An attempt is made to justify qualitatively the few equations which cannot be derived by first-year calculus.

Much care was evidently spent in bringing the book up to date. The results are especially noteworthy in the chapters on Photometry and Color, which are better even than those of any current *intermediate* text, by virtue of the recent discussion and clarification in these areas. These two chapters on psychophysical units per haps belong where they are, at the end of the book but one may hope that optics, even in elementary course will some day be swallowed up by radiometrics, in whi the quantities will all be measured in *physical* unit which can be then be discussed at the place where the belong in an exact science—that is, at the beginning o the course.

Some minor objections may be noted. Rigorous physi cists will find fault with several equations which ar dimensionally sloppy. Spectroscopists should protes against new texts which continue the emphasis on wav lengths rather than frequency or energy, but, of course the author cannot be blamed for following the custom Students will find difficult, as always, the unfamilia thermodynamic point of view in the chapter on Ther mal Radiation, as well as the unnecessary proliferation of units and symbols in Photometry and Color.

There are only a few mistakes. Several of them occur in the chapter on Polarization which, though good, seems less carefully written than the others. In particular, reflection and refraction are confused in dis cussing mirages and "looming." Fermat's principle of "extreme time" is restricted to "least time," thus making impossible the seeing of inverted images in a concave mirror! The false statement is made that the wave fronts in a biaxial crystal are ellipsoids.

On the whole, the book is one of the finest of elemen-y-intermediate texts now in the field and should be of the easiest from which to teach, except perhaps three or four less superior chapters out of the thir-n. The present volume suffers somewhat in attrac-eness as a result of wartime paper restrictions.

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e chemical process industries. R. Norris Shreve. New York: McGraw-Hill, 1945. Pp. xiii + 957. (Illus-trated.) $6.00.

This is a most worthwhile reference text for all chem-s, chemical engineers, chemical executives, chemistry d chemical engineering students, and others who are erested in an up-to-date and detailed account of the oduction methods for the manufacture of most of the re common chemicals and chemical products. Shreve's ok is a welcome addition to our industrial chemical ref-nces, of which there are several excellent books of cent edition, for it brings together for the first time a ser relationship of the unit operations and unit proc-ses involved with the actual industrial procedures. This most essential for a better scientific and engineering derstanding of these chemical processes.

The book is written from the viewpoint of the teacher d therefore serves well as a text for industrial chemistry urses. A discussion of the fundamental principles of emical engineering as treated in a general way in the rly chapters will provide the student with a better ap-reciation of the design, operation, and control features the processes to be discussed later. Instead of ar-nging the processes in the usual order of sulfuric acid, osphorus, soda, methyl alcohol, or aniline, the author vers these processes in a more logical fashion under roupings according to related manufacturing industries rolving similar raw materials and chemical changes, ch as fuels, ceramics, sodium salts, electrolytic products, ints, soaps, plastics, organic intermediates, etc. These e presented from an over-all standpoint to include the ndamental chemistry involved in the transformation of e raw materials into finished products, the process erations with specific conditions required, the essential sign and construction features of the equipment, prop-rties and industrial applications of the chemical products, nd the economic aspects of the process. Interspersed ith the descriptive material are many illustrations of the lant equipment as well as typical flow sheets of the proc-ses which are of help in obtaining a clearer idea of the anufacturing methods. At the end of each chapter are roblems and questions concerning the processes under iscussion which enable the student or reader to deter-ine in a practical way his mastery of these subjects.

There are few errors to be found in the text, which is compliment to the author and aides for their careful ollection of information, compilation of data, and pains-aking presentation of intricate details of so many chem-al processes. The only criticism to be offered by the eviewer is the reduced size of the flow sheets, which

NUTRITION OF THE DOG

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Professor of Nutrition, Cornell University

Combining in this book his study of the literature of nutrition with his practical experience as a kennel owner and consultant in the preparation of dog foods, Dr. McCay has written a guide for managers of kennels or owners of a single pet, as well as for veterinarians and research workers. Emphasis is placed on the carbohydrate, fat, protein, mineral and vitamin requirements of the dog and many formulas for feed mixtures are included. NUTRITION OF THE DOG is an excellent and authoritative summary of the information needed for the proper and economical feeding of dogs.

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makes them difficult to follow. Also, the organic section, presented mainly in the last two chapters of the book, is considerably brief in many respects and might well have been expanded to include more specific information on these processes, in keeping with the importance of the synthetic organic chemical industry, which is fast assuming a major proportion of the whole chemical industry. The treatment of the organic processes is much below the fine standard of the remainder of the book.

JAMES M. CHURCH

Columbia University

War neuroses. Roy R. Grinker and John P. Spiegel. Philadelphia: Blakiston, 1945. Pp. ix + 145. $2.75.

This book was written in the military theater in Africa at the end of the Tunisian campaign and first published in September 1943 by the Josiah Macy, Jr. Foundation. Because of military restrictions it received limited distribution at that time—principally to medical officers in the Armed Services. In the present edition only a few deletions and minor revisions have been made.

The subject matter, facts, findings, and opinions are based on the authors' observation of patients with acute neurosis in both Ground Forces and Air Forces personnel of British and American troops. Nine clinical syndromes are described: (1) free-floating anxiety states, severe and mild; (2) somatic regressions; (3) psychosomatic visceral disturbances; (4) conversion states; (5) depressed states; (6) concussion states; (7) exhaustion states; (8) psychotic states; and (9) malingering. Each syndrome is illustrated by one case history or more. These are very brief and contain little in the way of personality evaluation. This is an understandable defect in view of the environmental situation under which the authors were working.

The types of therapy used were narcosynthesis with sodium pentothal, brief psychotherapy, convulsive shock therapy (with frenisol, a British equivalent of metrasol), continuous sleep, occupational therapy, group therapy, and general convalescent care. Emphasis is given to narcosynthesis, which is used to induce a seminarcose state during which the patient relives his traumatic combat experiences. The authors do not mention that many workers for some years have been using this general uncovering technique with sodium amytal with some success in both military and civilian neuroses and psychoses. Credit for such work goes to Bleckwenn, Horsley (England), Broder, Palmer, Braceland, and others. No credit should be withheld from Grinker or Spiegel, for they probably are the first American psychiatrists to use this type of treatment in World War II.

War neuroses is a dramatic presentation of tense life situations involving human emotions and body responses expressed in a time of unusual stress—a global war. Civilian psychiatrists and associated workers in the field should gain additional insight into the neuroses of war from this volume.

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Scientific Book Register

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